MicroComputer JOURNAL

The print forum for the MicroComputer professional and semi-professional

September/October 1995

Affordable Non-Linear PC Video Editing

- Dispelling Myths & Rumors About Enhanced IDE
- Hardware & Software For Fixing Ailing PCs
- Building Ultra-Low-Power Microcontroller Projects

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8051 based Controller & Languages

Program it in:

Basic, C, Assembly, or FORTH.

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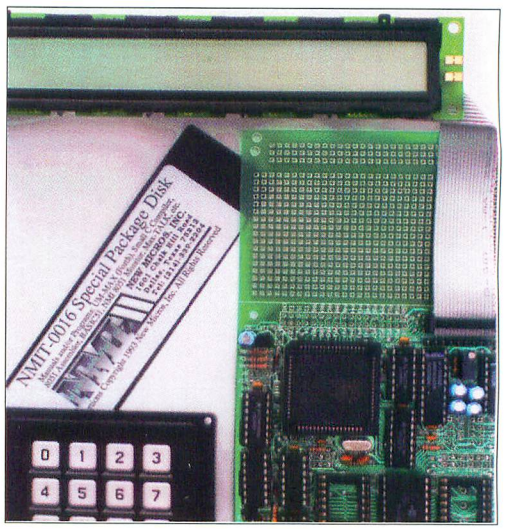
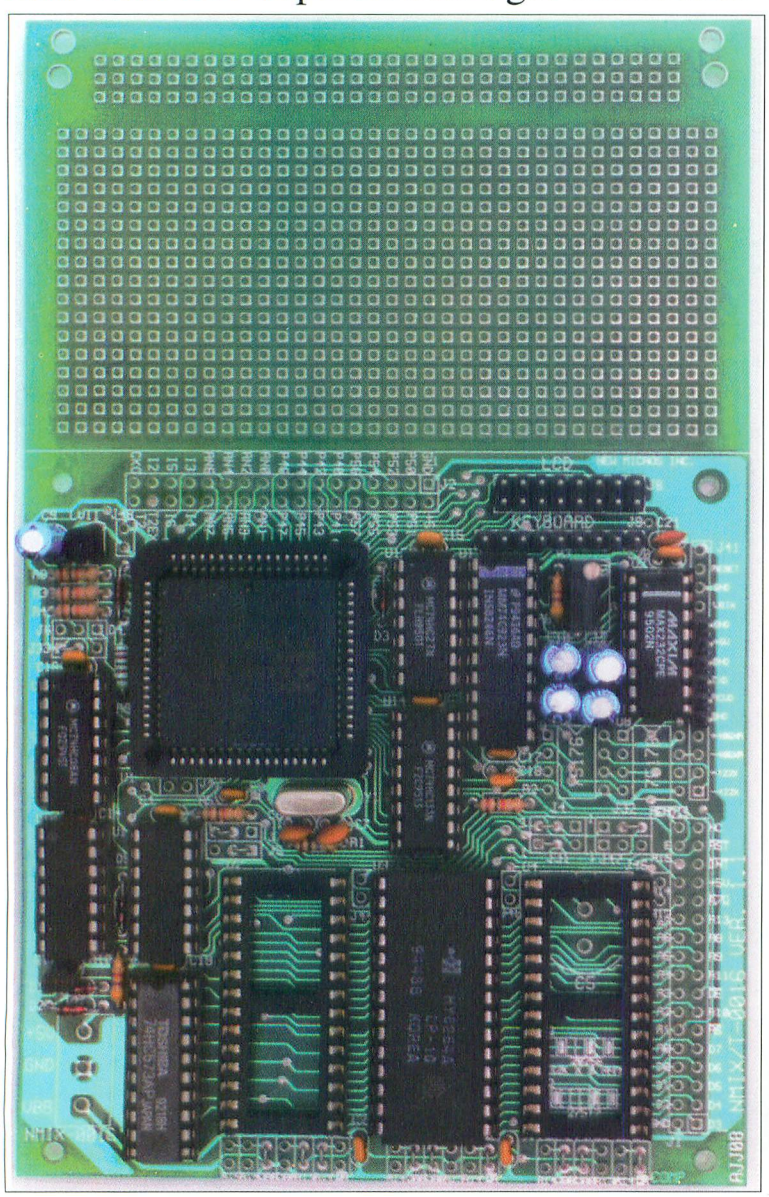


Low Cost Development Package: **Controller + Languages** + Manuals on disk included!



Package Price Breakthrough!

The NMIT-0016 Single Board Computer is perfect for dedicated controller applications. Convenient interfaces for LCD display and keypad are included. Intelligent LCD's up to 2 lines by 80 characters and matrix keypads up to 4x5 can be used. The processor is the popular 80535 with many features, including SCI and SPI serial channels, 8-bit 8-ch. A/D, 32 other I/O lines, Watch Dog Timer, 3 16-bit timers with reload, compare, capture. SBC expands 80535 providing 3 28-pin JEDEC sockets for 8-32K RAMs, ROMs, EPROMs, EEPROMs, etc. Combined 64K and Harvard 128K addressing supported. RS-232 conversion supplied. Requires external regulated supply: 5V at ~30 mA. NMIT-0016 is based on more expensive NMIX-0016, so many features may be added. (Fully configured NMIX-0016 available @ $140, call for details. Rev A CPU with 10-bit A/D substituted for $10 adder.)

Max-FORTH installed on-board in EPROM. Other Languages supplied on accessory disk: Small C, Basic, Monitor, Assembler. Languages come with manuals on disk. Communications utility, MAXTALK included to allow PC clone to act as terminal for download and development. Manuals on disk: UM-MAX Max-FORTH Users Manual, HM-16 NMIX-0016 Hardware Manual, Small C manuals with examples, BASIC Manual.

SBC and utility disk - $89. Keypad and LCD not included, available separately. Great value! Call today!

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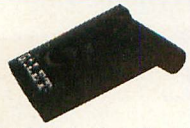

Output: >4 mW; Swivel head; 670nm; weighs less than 2.5 oz.; 4" x 2" x 7.5"; Dual mode-continuous/blink; Visible up to 150'; Runs on 2 AAA batteries.

Stock#	1-9	10-24	25+
GALET	59.99	56.99	51.29

Collimating Lens

Black anodized aluminum barrel; Glass lens with 7.5mm focal length. Fits 9mm laser diodes sold below. easy to focus and install.

Stock#	1-9	10-24	25+
LSLENS	24.99	23.74	21.37

Eprom Programmer

Programs all EPROMS, EEPROMS, including flash memories. Programs microcontrollers with optional adapters. Complete with software, programming module, cable & manual. Single Device programming.

Stock#	1-9	10-24	25+
ROMMAX	169.99	161.49	145.34

Eprom Eraser

Shirt pocket size handles up to 4 devices at a time. Auto start, erases most EPROMs/EPLDs in 3 minutes. Molded plastic case.

Stock#	1-9	10-24	25+
DE2	39.99	37.99	34.19

Universal Programmer

Programs PROM, EPROM, EEPROM, Flash EPROM, serial PROM (8 pin), bipolar PROM, PLD, GAL, PAL, EPLD, PEEL, and mmicrocontroller. Tests logic ICs (TTL/CMOS), and memory (DRAM/SRAM).

Stock#	1-9	10-24	25+
ALLMAX	549.99	522.49	470.24

Laser Pointer

- < 4 mW output
- 0.5" dia. x 5" long
- 150 ft. range

Stock#	1-9	10-24	25+
NBK	59.99	56.99	51.29

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Switching Power Supply

- 115/230 V input
- 41 watt
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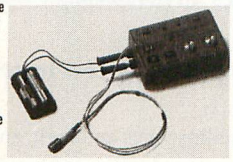
- 7" L x 5.25" W x 2.5" H

Stock#	1-9	10-24	25+
PS1003	17.99	17.09	15.38

Versatile Laser Diode Module

This small instrument houses a complete system to test and understand the laser diode. With its built-in driver circuit, flasher control, and applied power variations, it enables the designer to develop the skills of creating driver circuits and power conditions for the laser beam system. These circuits can be simply tested by plugging them into three pin sockets on the front panel.



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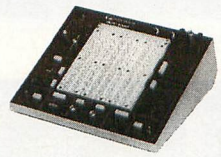

Stock#	1-9	10-24	25+
PB503	259.99	246.99	222.29

Laser Diodes

Stock#	Mfr.	Wavelength	Output	1-9	10-24	25+
LS9520	Toshiba	635nm	3 mW	139.99	132.99	119.69
LS9521	Toshiba	635nm	3 mW	109.99	104.49	94.04
LS9321	Toshiba	660nm	5 mW	49.99	47.49	42.74
LS9200	Toshiba	670nm	3 mW	29.99	28.49	25.64
LS9215	Toshiba	670nm	10 mW	79.99	75.99	68.39
LS9140	Toshiba	685nm	20 mW	169.99	161.49	145.34
LS9150	Toshiba	690 nm	30 mW	269.99	256.49	230.84
LS022	Sharp	780nm	5 mW	17.99	17.09	15.38
SB1053	Phillips	820nm	10 mW	10.99	10.44	9.40

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The PV381 by Panavise is a versatile vise with added portability. A half turn of the mount lever attaches or releases the powerful suction pad and allows rapid set-ups in a variety of locations on smooth, non-porous surfaces.

Stock#	1-9	10-24	25+
PV381	47.99	45.59	41.03

Robotic Arm Kit

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Y01	43.99	41.79	37.61
Y011BM	35.99	34.19	30.77

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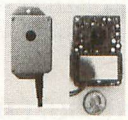
- Auto iris
- Supply voltage- 12 VDC @ 140 ma
- Wide angle lens
- 1.8" W x 2.7" L x .81" H
- Weighs 2.14 oz.
- V1206SVS includes a plastic case



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- Weighs 3 lbs

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- Adjustable 3 element glass AR coated lens
- Brass barrel acts as heat sink
- Adjustable at 40 TPI
- Fits all 9 mm laser diodes

Stock#	1-9	10-24	25+
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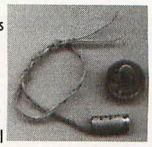
Laser Module

- Adjustable 3 element glass AR coated lens
- Operates on 3-6 VDC
- Internal automatic power control circuitry
- 5 mW output
- .750" L X .400" D



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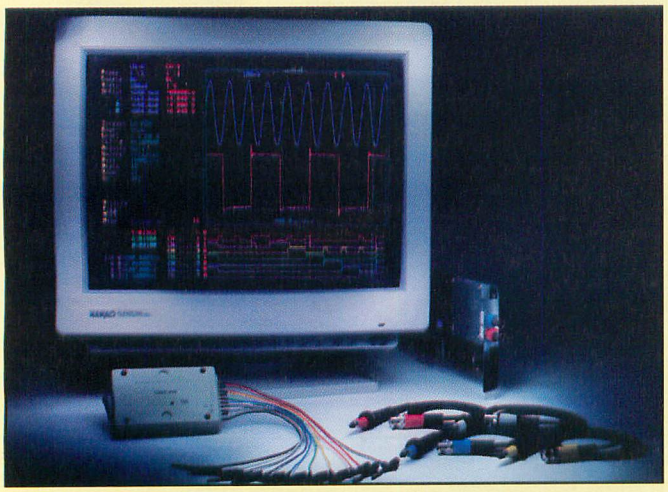

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Features

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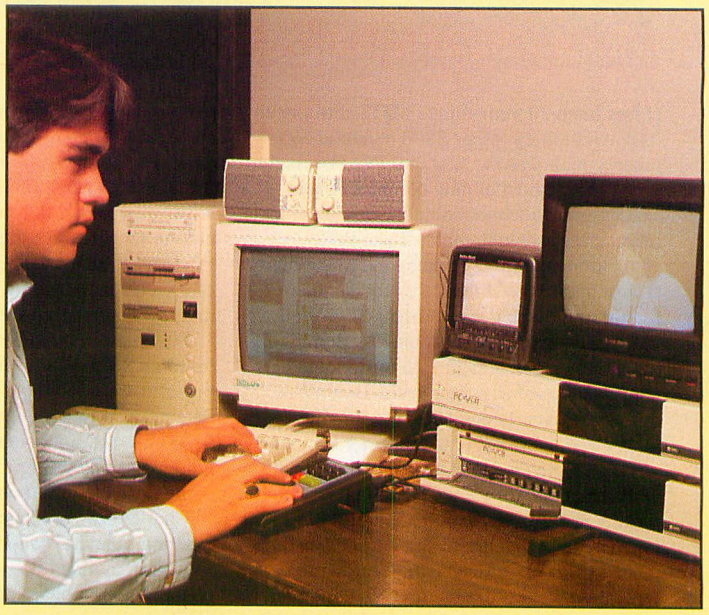

In This Issue

The longer personal computers are around, the more-sophisticated and affordable become the things you can do with them. For example, being able to do professional-quality video production work for composition on VHS videotape has become possible, practical and affordable. This is due in no small part to Miro's Motion MJPEG capture card, as described in Tom Benford's "Non-Linear Video Editing on a PC" article beginning on page 47. Tom also describes Miro's video mouse that takes much of the pain out of controlling two VHS VCRs while doing video producing. As a companion piece, he evaluates the Asymetrix *3D F/X* software package (page 49) that lets you make dazzling drag-and-drop 3D effects for less than $100.

If you're confused about the new IDE standards (and who isn't with the plethora of new jargon in this area?), you'll definitely want to check out TJ Byers' "Enhanced IDE: Dispelling the Myths and Rumors" on page 12. On page 40, Hardin Brothers brings you up to speed on "Fast Modems," telling you what you need to know to make an intelligent buy decision based on your needs.

For those of you who are "hardware oriented," Jan Axelson details the hardware and software available for turning a PC into an oscilloscope or logic analyzer in "Using Computers as Test Instruments" beginning on page 30. Joe Desposito's "Fixing PC Problems" (page 20) is must reading for anyone who owns or operates a PC. Joe discusses hardware and software products that can help you get a cranky PC back into working condition.

In Part 3 of his "A PIC16C71 Development System" on page 60, Duane M. Perkins shows you how to add non-volatile RAM and a real-time clock to the project begun two issues back. Wrapping up our Features section, Philip Doucet and Robert Grappel guide you through hardware and software tricks to use to obtain the longest possible operating life from the batteries in portable equipment. Their "How to Build Ultra-Low-Power Microcontroller Projects" begins on page 62. The authors also include as a bonus a build-it-yourself Data Logger project that operates for up to a year on a single 9-volt battery.

Cover Photo By Joe Abbato/The Photography Place

Editorial By Art Salsberg

Disappearing Technophobia

It has been 20 years since MITS introduced its revolutionary Altair 8800 personal computer, which was the first real PC. For many years after, a host of new computer users experienced "technophobia." Computers terrified a very large number of neophytes.

As more and more people took to the digital machines, you'd think that the number of fearful users would rise dramatically. Well, maybe this happened for a lengthy period of time, but the percentage with this phobia certainly decreased in recent years. Doubtless, this is due to early computer training in school and the brave new computer business world in which we live. Very few people are now afraid that they'll ruin a computer if they make a mistake. In fact, a recent poll in EDK Forecast (a newsletter for women consumers) reports that only 6% have this fear, while 16% have no idea of how to use a computer.

Using a computer is fun, challenging and, for a great number of people, necessary in the job world. According to the EDK poll of Americans aged 18 through 60, 74% use computers either at work or at home, with 37% plugged into them in both places. The transition to Microsoft *Windows* and other GUIs that feature drop-down menus activated by mouse clicks paved the way to ease computer fears.

Fear of computers, however, may well rise, I believe, although it will be a different kind of apprehension. It has to do with hardware and software problems that seem to be rampant. Every time you turn around, the rock-solid machines and software (after fine-tuning and a few upgraded versions or corrective patches have been taken care of) have to be replaced by newer, faster, better stuff. And with them, come problems: hardware and software bugs, IRQ conflicts, memory-juggling difficulties, incorrect configuration setups, and so on.

Whichever way you turn, there's wariness about changing a smooth-running system. And when you do make the move(s), great anxiety usually occurs. Too often, it happens before you get a "successful installation" notice.

Should you load up with *Windows 95*... or wait, OS/2 *Warp*...or wait, buy a 28,800-bps modem...or wait. The last might seem to be perfectly safe but, then again, might turn out to be incompatible with other 28.8K modems, especially ones that don't comply with the new V.34 standard. Moreover, manufacturer interpretations of the new standard could vary slightly from one maker to another, giving rise to minor problems. There's generally a shakedown period before everyone gets on the same bandwagon. This even occurred with the RS-232 serial port early on.

The V.34 standard was only approved in June; formal ratification is expected to be completed in September 1995. Doubling the transfer rate from 14,400 to 28,800 bps is great, so long as it's error-free and has widespread interoperability with other users. Consequently, I wonder about some of the cheap ($170) 28.8K modems' worthiness as compared to the name-brand ($259) ones. Pre-standard ones, such as V.Fast Class or V.FC modems, don't incorporate the technology to maximize the likelihood of two modems at 28.8K bps communicating properly. Without it, the V.FC modems will drop to a lower operating speed more often.

So what does one consider when moving up to 28.8K bps? For one, the modem should be software-upgrade-able, says AT&T. Secondly, at this time, only AT&T has the V.34 chip set on the market with V.flex technology for upgrading via software to overcome possible initial compatibility problems.

Challenges you'll face as you improve equipment and expand its functions abound, as it does in many non-computer areas. My cellular telephone number was ripped off last week, for example. I learned that it was done by high-tech scanning equipment near a toll booth or near a high-class NY restaurant. The way to minimize a recurrence in the future, I was told, is to shut off the phone's power whenever approaching a toll booth or in mid-New York City.

One might well worry about making on-line payments for purchases, too. Interestingly, a throaty voiced female robot called CARI reportedly gives businesses a secure way to sell by credit card in the fast-growing Internet marketplace. CARI (Collect All Relevant Information) allows customers to purchase goods and services over the Internet's World Wide Web without exposing credit-card numbers to computer hackers. Here, customers obtain a "virtual credit card number" that's useless to hackers because the actual number never goes on-line. Only the buyer and seller know the actual number. To set it up, you talk to CARI on the phone first, giving it the actual credit-card number, which CARI stores and then assigns a virtual number, which is used on-line. Cute, huh!

This is set up by Information Technology Partners in Milford, CT (tel.: 203-878-0660 or info@netresource.com). To hear CARI's voice, call for a demo at 203-878-8789 and enter 999-9999 when it asks for a number.

As we move forward in the computer world, don't panic. Look upon stripping TSRs one by one to learn if one is causing a problem, check out the various bulletin boards for fixes, and view it all as an interesting challenge. And if you experience a bit of technophobia, remember that you can't "hurt" anything so long as you back up everything first. Be sure to have a clean boot disk at hand, as well as pen and pad to note what you do on your technical journey. Have no fear, you'll get through it with flying colors.

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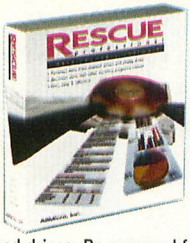

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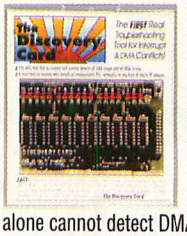

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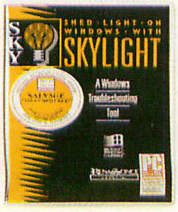

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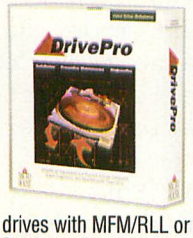

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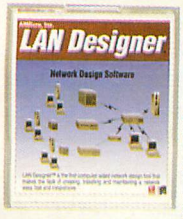

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FIRST TWO-WAY CABLE MODEM. The first two-way cordless cable modem was unveiled by Zenith Electronics Corp. It provides universal computer compatibility, easy installation and increased network monitoring capability. Called "HomeWorks Universal," it has high-speed data capability—4M per second or 500K-bits per second—and connects to IBM/compatible PCs and Apple Macintosh computers. Subscribers will have opportunities to share documents, work at home, distance learning, videoconferencing, advanced graphics and access to on-line services. In addition, the system becomes a diagnostic tool for network providers through constant monitoring. The first cable operator to deploy HomeWorks Universal will be Rogers Cablesystems through a trial with IBM Canada's Flexiplace work-at-home program in Newmarket, Ontario, Canada.

S.M.A.R.T. DATA PROTECTION FOR DISK DRIVES. A handful of leading disc-drive makers agreed to support a new set of data reliability specifications to enable systems manufacturers to warn users if a disk drive is in danger of losing any stored data. The technology, called "Self-Monitoring, Analysis and Reporting Technology," was pioneered by Compaq Computer Corp. It will be incorporated into ATA/IDE disk-drive products from supporting manufacturers, including Seagate, Conner, Western Digital, IBM and Quantum.

SERIAL COMMUNICATIONS TROUBLESHOOTING TOOL. B&B Electronics announced a shareware program to help solve serial communications problems. Called "SimpTerm" (for SIMPle TERMinal), the emulator allows you to open four ports at a time, at any address and IRQ, with user-definable Receive and Transmit Buffer sizes. It also features a Monitor Mode that lets you monitor communications between two devices while remaining transparent to them. This requires open serial ports and cubing adapters that are available from B&B. Other features include 16550AFN FIFO/TRIGGER control, data logging, macros, any baud rate and loop-back test mode. Software can be downloaded from the company's 24-hour BBS at 815-434-2927. Also from CompuServe's bulletin board. If you like the program, a $50 registration fee is requested. To register through CompuServe, type "GO SWREG" and use registration number 5281.

CD-PLUS MERGES MUSIC & MULTIMEDIA. Sony Music Entertainment premiered its Compact Disc-Plus offerings from a number of popular recording artists. It combines the full audio range of a compact disc with CD-ROM data in one multisession 3.5-inch floppy disk that can be played on existing CD audio players and CD-ROM drives. When played on a CD-ROM drive, the disk's interactive portion is recognized, in addition to full CD-quality sound. The discs provide music audio and video, album artwork, song lyrics, liner notes, photos, biographies, interview clips and more. Titles also present full-motion video, highlighting album tracks. The disk compresses a minute of video onto a 1.4M floppy disc, compared to almost 9M of storage space on the average CD-ROM. Users also have the option of installing any number of titles on their computers since each disk has a "virtual carousel" function to emulate a multi-disc CD player.

TV VIDEO SCREEN SAVERS. Screen savers, those software programs that automatically change pictures on a computer's video monitor to eliminate burn-in problems, have advanced. Now a new company, Two Nerds And A Suit, Inc., introduced a CD-ROM screen saver for Windows that uses motion-picture film with full-screen pictures. The $19.95 CD-ROMs are named "ReelLife." Subjects include sports, famous faces, nature and wildlife, America, exploring outer space, and more. The company's first product is a CD-ROM sampler of six different subjects composed of 170 full-motion film clips.

AT&T ADVANCED SPEECH APPLICATIONS. AT&T Bell Labs announced availability of licenses for the AT&T Watson ASAP family for advanced speech-application products. It permits voice control of personal computers, workstations and telephones. Such voice control permits users to speak to and receive vocalized response from their computers. It could allow transformation of a PC or next-generation telephone into a personal digital assistant or receptionist.

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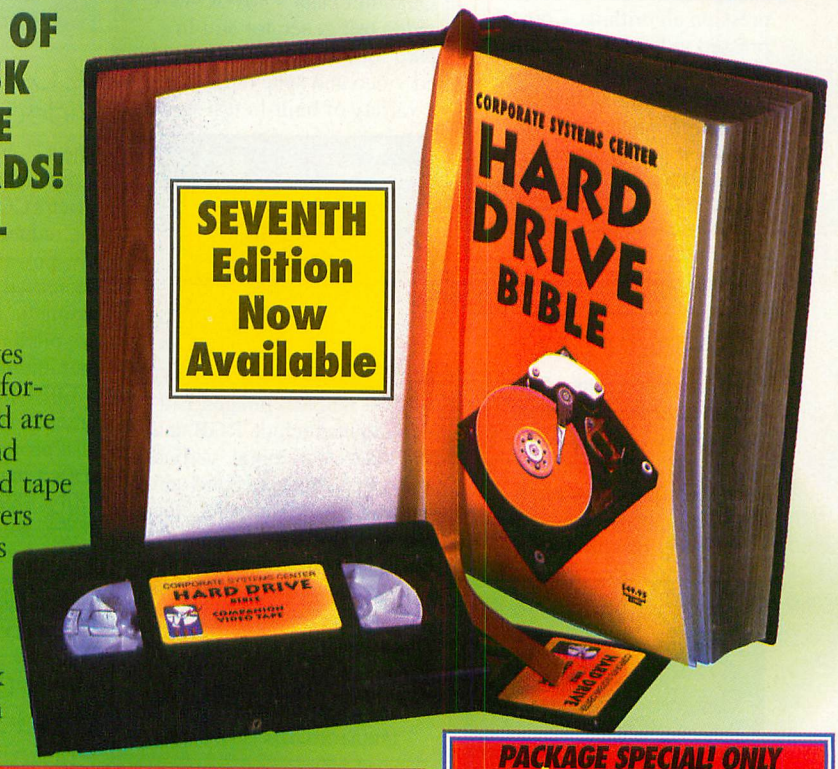
HARD DRIVE BIBLE

THE DEFINITIVE COMPILATION OF EVERYTHING ABOUT HARD DISK DRIVES, OPTICAL DRIVES, TAPE DRIVES AND CONTROLLER CARDS! BACKGROUND AND TECHNICAL DETAILS ON HUNDREDS OF DEVICES, ALL IN ONE BOOK!

The guys who wrote the book on hard drives now bring you years of experience and technical information in our all new Hard Drive Bible. Included are installation instructions, drive parameter tables, and setup information on hundreds of hard, optical, and tape drives. Be sure to check out the new SCSI Parameters chapter, one of many new features. Jumper settings and compatibility information on controller cards and driver software have all been revised and updated. Don't miss the benchmark chapter with performance and reliability test reports. This book and software are essential for all dealers and system integrators who install hard drives.



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- Low level, partitioning, and high level format instructions.
- Installation hints for IDE, SCSI, MFM, ESDI, and RLL interface drives.
- Free copy of CSC's drive performance test software and low level format programs.
- Free copy of Seagate's technical support software.

Hardware

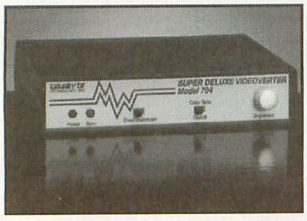
Video-Editing Card

Quadrant International's QI-MJPEG+ ISA-bus video editing card lets you capture video in realtime at resolutions up to 640 x 480 in full color. Incoming video can be compressed in realtime using industry-standard Motion-JPEG compression algorithms. Compressed video can be read back from your hard drive and decompressed in realtime for TV-quality playback. *Quadrant International, 170 S. Warner Rd., Ste. 102, Wayne, PA 19087; tel.: 610-964-7600; fax: 610-964-8195.*

CIRCLE NO. 1 ON FREE CARD

VGA-to-TV Link

The Model 704 Super Deluxe Videoverter from Telebyte Technology converts VGA images to NTSC TV format. The device is equipped with S-VHS, composite, and r-f outputs. Since the outputs are



available simultaneously, the unit can drive three different output devices. The Model 704 supports VGA up to 640 x 480 with 64K colors. A DOS TSR software driver is included. $435. *Telebyte Technolgy, Inc., 270 Pulaski Rd., Greenlawn, NY 11740; tel.: 800-835-3298; fax: 516-385-8184.*

CIRCLE NO. 2 ON FREE CARD

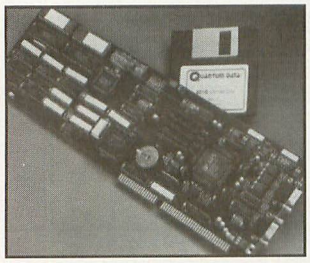
High-Resolution Frame Grabber

Digital Vision's ComputerEyes/1024 high-resolution video frame grabber for PCs is a 16-bit ISA-bus card that grabs video data at 1,024 x 512 samples and true 24-bit color depth from any composite, S-video or RGB video source. The device also captures motion .AVI files at up to 320 x 240 at 30 frames per second. $599.95. *Digital Vision, Inc., 270 Bridge St., Dedham, MA 02026; tel.: 617-329-5400; fax: 617-329-6286.*

CIRCLE NO. 3 ON FREE CARD

150-MHz Video Test Generator

Quantum Data's 801GC-ISA video test generator add-in card for PCs provides protected video and sync outputs and a variety of built-in test signal

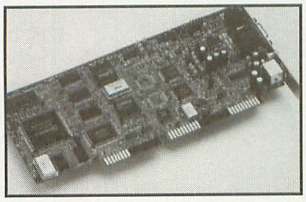


formats and test images. Signal outputs include RGB analog video; horizontal, vertical and composite sync; and vertical frame lock and pixel clock outputs. Horizontal frequency range is programmable to 130 kHz, while vertical timing frequency range is to 650 Hz. *Quantum Data, 2111 Big Timber Rd., Elgin, IL; tel.: 708-888-0450; fax: 708-888-2802.*

CIRCLE NO. 4 ON FREE CARD

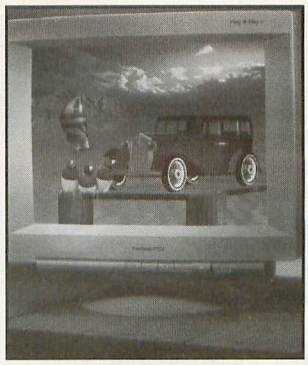
MPEG Playback Card

Visonetics' MPEG Master 95 MPEG playback multimedia interface card features full-motion video and CD-quality audio and supports the industry-standard MPEG full-motion video and audio formats. Its design permits simultane-



ous output of both VGA and NTSC (30 frames per second). $299. *Visionetics Int'l. Corp., 21311 Hawthorne Blvd., Torrance, CA 90503; tel.: 310-316-7940; fax: 310-316-7457.*

CIRCLE NO. 5 ON FREE CARD



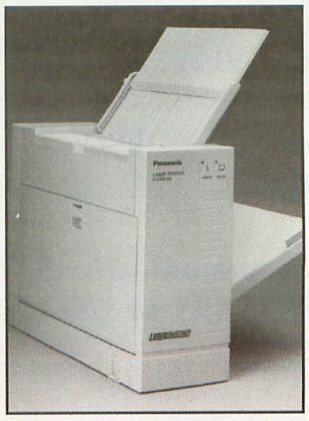
TCO-Compliant Video Monitor

The 17" ViewSonic 17GS video monitor complies with strict TCO standards, including reduced heat emissions, low power consumption and decreased exposure to electromagnetic fields. The 0.27-mm dot pitch monitor features maximum resolution of 1,280 x 1,024 and refresh rates as great as 160 Hz. The 17GS also provides Plug and Play (DDC1 and DDC2B) compatibility. $895. *ViewSonic Corp., 20480 Business Pkwy., Walnut, CA 91789; tel.: 909-869-7976; fax: 909-869-7958.*

CIRCLE NO. 6 ON FREE CARD

Ultra-Compact Windows Laser Printer

Panasonic's KX-P6100 six-page-per-minute laser printer is housed in an enclosure that has a mini-tower form factor. Designed for *Windows* users, it employs the company's new proprietary laser engine, which achieves 600-dpi-class print quality through edge-enhance-



ment technology (EET). The printer also incorporates a photo enhancement feature. *Windows* utility software is included. $499. *Pansonic Communications & Systems Co., Two Panasonic Way, Secaucus, NJ 07094; tel.: 201-348-7000.*

CIRCLE NO. 7 ON FREE CARD

Compact Color Printer

Canon's 3-pound BJC-70 Bubble Jet color inkjet printer combines small size with four-color output and a 30-page sheet feeder. Resolution is 720 dpi for black text and 360 dpi for color. Speed is approximately four pages per minute for monochrome and 0.8 ppm for color. The printer comes bundled with *Color Advisor* software. The BJ-30 is the monochrome counterpart to the BJC-70. This printer features 720 x 360-dpi print resolution and smoothing options. $399/$299. 70/30. *Canon Computer Systems, Inc., 2995 Redhill Ave., Costa Mesa, CA 92626; tel.: 714-438-3000; fax: 714-438-3099.*

CIRCLE NO. 8 ON FREE CARD

SMT Repair Kit

Pace's SMT ThermoBond Cir-Kit lets you repair and modify surface-mount lands and other circuit elements to meet origi-

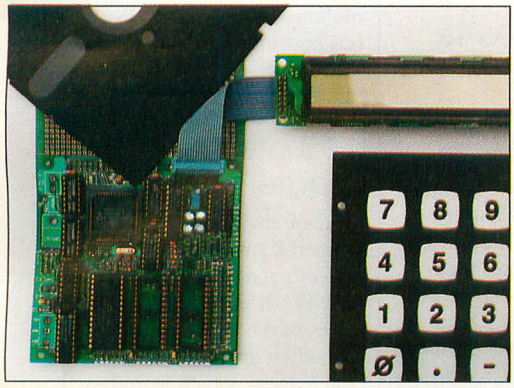
nal board quality and reliability. The kit's frame incorporates a dry-film adhesive backing that hot bonds in 15 seconds at safe, low temperatures. $200. *Pace, Inc., 9893 Brewers Ct., Laurel, MD 20723; tel.: 301-490-9860; fax: 301-498-3252.*

CIRCLE NO. 9 ON FREE CARD

68HC11 Controller & Languages

Program it in **C**

$99



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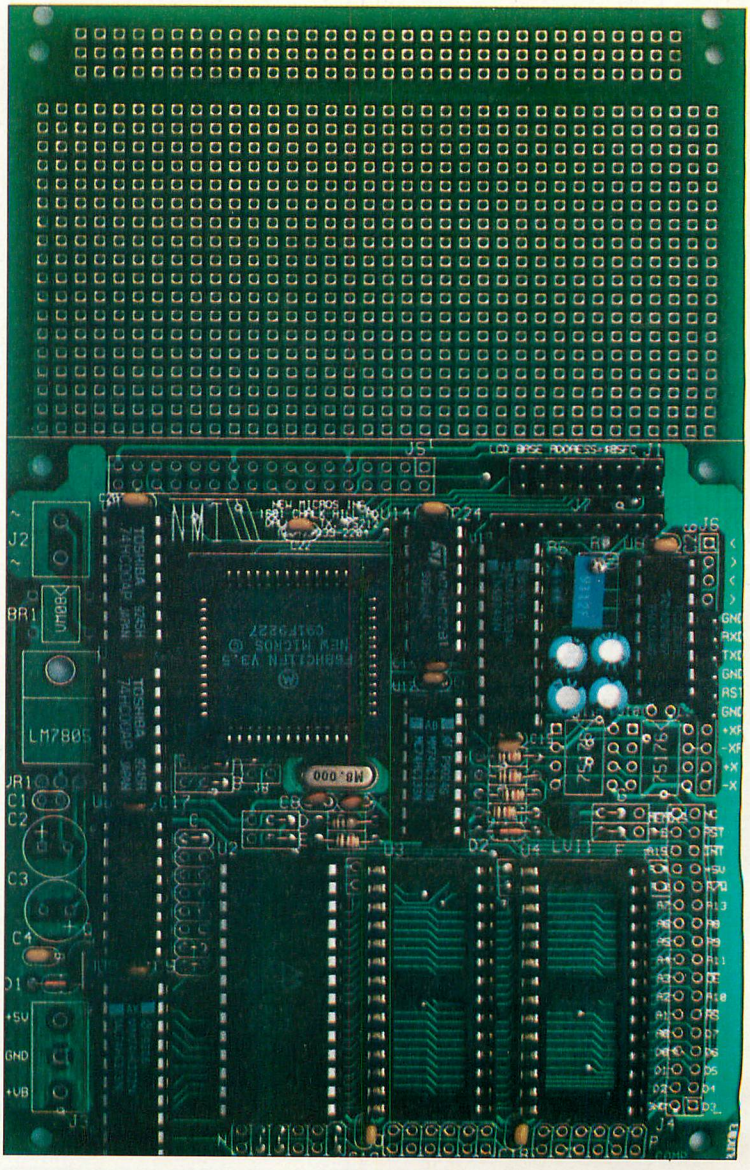
The NMIT-0020 Single Board Computer is perfect for dedicated controller with convenient interfaces for LCD displays and keypad. Intelligent LCD's up to 2 lines by 80 characters and matrix keypads up to 4x5 can be used. The processor is the popular F68HC11 with many features, including SCI and SPI serial channels, 8-bit 8-ch. A/D, 20 available I/O lines, Watch Dog Timer, 1/2K EEPROM and Max-FORTH w/Floating Point Package embedded in 12K internal ROM. SBC expands F68HC11 providing 3 28-pin JEDEC sockets for 8-32K RAMs, ROMs, EPROMs, EEPROMs, etc. RS-232 conversion supplied. Requires external regulated supply: 5V at ~30 mA. Based on NMIX-0020 board, so, many features may be added as desired by the user (or by factory - fully configured NMIX-0020 Ad-special available @ $145, call for details).

Languages supplied on accessory disk: Small C, Basic, and Assembler. FORTH resident on chip (may be disabled). Languages come with manuals on disk. (Printed manuals extra.) Communications utility, MAXTALK included to allow PC clone to act as terminal for download and development. WIPE utility included allows internal ROM, EEPROM, WDT to be enabled/disabled, and EEPROM to be erased. Manuals on disk: UM-MAX Max-FORTH Users Manual, HM-20 NMIX-0020 Hardware Manual, Small C manuals with examples, BASIC11E9 Manual.

SBC and utility disk - $99. (Keypad and LCD not included. Available separately.) Great value. Call today! New Micros, Inc. Tel: 214-339-2204, Fax: 214-339-1585.



NEW MICROS, INC.
1601 Chalk Hill Road
Dallas, Texas 75212
Tel: (214)-339-2204

CIRCLE NO. 80 ON FREE INFORMATION CARD

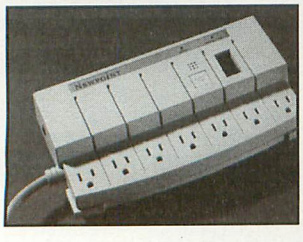
Wireless Printer Sharing

AeroComm's GoPrint wireless printer-sharing device features a 2.4-GHz Spread Spectrum radio that permits a computer to output to a printer in a radius of up to 3,000 feet unobstructed and up to 200 to 500 feet indoors. GoPrint transmits at speeds up to 1M bps. Adapters plug directly into the parallel port of computers and the Centronics port of printers. Multiple computers can output to the same printer or up to eight printers in the same office. $225 per adapter. *AeroComm, 13228 W. 99 St., Lenexa, KS 66215; tel.: 913-492- 2320; fax: 913-492-1243.*

CIRCLE NO. 10 ON FREE CARD

Remote Power Protection

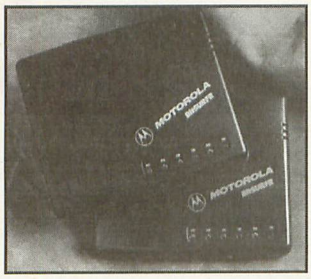
Newpoint's Phone Director power control surge protector lets you remotely power up, re-boot or power down your system from any location. Using a Touch Tone telephone you can remotely turn on up to seven components, including computers, peripherals and other electronic devices. Remote users can also power down all connected components by pressing one Touch Tone key. The product also offers computer-grade surge protection and modem and fax-line protection. $119.95. *Newpoint Corp., 6370 Nancy Ridge Dr., San Diego, CA 92121; tel.: 619-677-5700; fax: 619-558-1408.*



CIRCLE NO. 11 ON FREE CARD

Digital Modem

Motorola's BitSURFR TA210 Digital Modem terminal adapter connects directly to ISDN lines through a built-in NT1. The modem achieves a data-transmission rate of 64K bps. *HyperACESS* software is included. $495. *Motorola, Transmission Products Div., Huntsville, AL; tel.: 800-451-2369.*

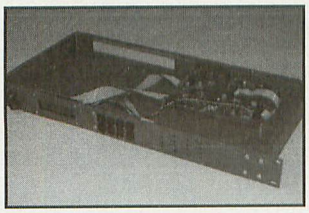


CIRCLE NO. 12 ON FREE CARD

Dual-DSP Sound

Ensoniq's Soundscape Elite PC sound card features custom dual DSPs on-board to provide 16-bit, 32-voice wavetable sound and simultaneous, download-able, realtime effects. The card can run such special effects as reverb, chorus, flange, distortion, pitch and phase shift and equalization in simultaneous realtime. $289. *Ensoniq, 155 Great Valley Pkwy., Malvern, PA 19355; tel.: 610-647-3930; fax: 610-647-8908.*

CIRCLE NO. 13 ON FREE CARD



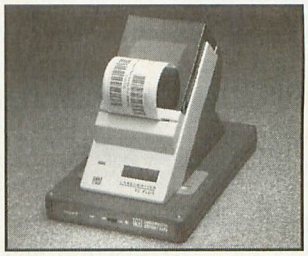
MIDI Kit

The MIDItools Custom Instrument Kit from PAVO lets you build a MIDI controller. The kit includes a painted rack-mount enclosure, back-lit LCD panel, all components and instructions for selecting and connecting a variety of sensors and switches. *PAVO, 10 Front St., Philadelphia, PA 19106; tel.: 215-413-2355.*

CIRCLE NO. 14 ON FREE CARD

Labelwriter Battery Pack

The LabelWriter Battery Pack is designed for user's of CoStar's LabelWriter printers who want portability. Weighing 3.6 pounds, this battery pack fits under any CoStar LabelWriter and features lead-acid battery technology to provide an average of 6.5 hours of portable power. A battery charger is included. $299. *CoStar Corp., 100 Field Point Rd., Greenwich, CT 06830; tel.: 203-661-9700; fax: 203-661-1540.*

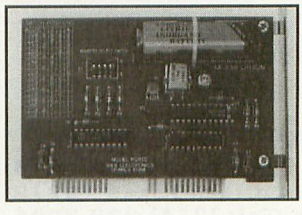


CIRCLE NO. 15 ON FREE CARD

Accurate Clock

B&B Electronics' Model PCRTC accurate, temperature-stable, realtime clock for PCs is based on a highly stable oscillator circuit. The PCRTC's clock uses a software driver to update the DOS clock every minute. The eight-bit card reduces the PC's clock error to 15 seconds/month or less than 5 seconds/month when operating in a temperature-stable environment. When power is off, a 3.6-volt lithium battery maintains the clock. $129.95. *B&B Electronics Mfg. Co., 707 Dayton Rd., PO Box 1040, Ottawa, IL 61350.*

CIRCLE NO. 16 ON FREE CARD

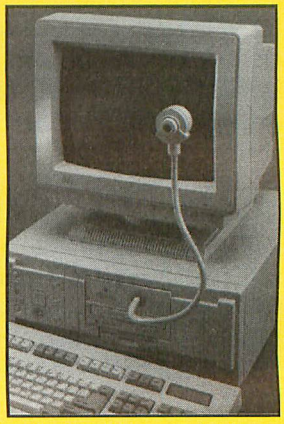


PCMCIA Reader/Writer

Antec's Descartes PCMCIA PC Card reader/writer internal drive for desktop PCs has a dual-socket design that permits two PC Cards to be used simultaneously. A 16-bit ISA-bus host interface card is in-

Drive-Bay-Mounted Camera

VideoLabs' FlexCap video camera/capture card mounts directly into the drive bay of any PC. It integrates the features of the FlexCam video camera with a low-noise digital camera, which includes complete video-capture functions. The camera head uses a high-resolution 1/3" color CCD with eight, 16 or 24 bits per pixel and provides digital pan/ tilt at CIF or QCIF resolution.



Designed to operate in low-light environments, FlexCap has a sensitivity of 2.5 lux at f/2.0 and includes programmable white balance and shutter with automatic gain control. A standard NTSC interface is available, as is a CCIR 601 interface. Two microphones in the camera head permit the sound signal to be passed through the system directly to a third-party sound card. *VideoLabs, 10925 Bren Rd. E., Minneapolis, MN 55343; tel.: 612-988-0055; fax: 612-988-0066.*

CIRCLE NO. 17 ON FREE CARD

cluded. $149. *Antec, Inc., 2859 Bayview Dr., Fremont, CA 94538; tel.: 510-770-1200; fax: 5110-770-1288.*

CIRCLE NO. 18 ON FREE CARD

TV Controller With TV Sniffer

CompCo Engineering's X-10 TV Controller uses two-way X-10 communication to control a TV receiver's power, channel and volume from any X-10 transmitter. With a built-in TV sniffer, the Controller monitors the receiver's power status and reports when the receiver is turned off or on by any means, including remote control, front-panel switch or otherwise. The X-10 TV Controller can even be polled for the TV receiver's status and reports back. Combining the "control from anywhere" feature of X-10 with the "many command" feature of infrared and adding in two-way communication, CompCo claims, takes home automation into a new era. $149.95. *CompCo Engineering, Inc., 611 Parkway, Ste. 4D, Gatlinburg, TN 37738; tel./fax: 615-436-5189; BBS: 615-436-6333.*

CIRCLE NO. 19 ON FREE CARD

Software

PC Memory Doubler

Landmark's *MagnaRAM* program is designed to boost the effective system memory of a PC running under *Windows* by two or more times the amount of installed physical RAM. The software uses a compression technique that creates extra *Windows* virtual memory for running more *Windows* applications faster. $69. *Landmark Research Int'l. Corp., 703 Grand Central St., Clearwater, FL 34616; tel.: 800-683-6696; fax: 813-443-6603.*

CIRCLE NO. 20 ON FREE CARD

Hurricane For Windows

Helix Software's *Hurricane* utility is designed to speed up *Windows* and *Windows for Workgroups* (*Windows 95* support is provided via a free upgrade). *Hurricane* consists of three major components: Discover for Windows, which analyzes *Windows*, DOS and your PC; WinGuage, which is a realtime monitor that reports on problems and conflicts; and the Hurricane Utilities tools that solve speed, resource and reliability problems. $79.95. *Helix Software, 4709 30 St., Long Island City, NY 11101; tel.: 718-392-3100; fax: 718-392-4212.*

CIRCLE NO. 21 ON FREE CARD

Model Letters

Model BusinessLetters, *Model SalesLetters* and *Model-Speeches* from Model Office provide ready-to-use letters and memos that cover a wide range of business topics. Each program includes its own database, word processor and spell checker. The letters were written by Dianna Booher, a leading business communicator. $69/$69/$89. *BL/SL/SP. ModelOffice, 4815 W. Braker Ln., Austin, TX 78759; tel.: 512-302-3888.*

CIRCLE NO. 22 ON FREE CARD

Remote Control for Networks

Norton-Lambert's *Close-Up/LAN Pro* remote-control network communication software supports classroom and workgroup environments in *Windows* and DOS. The software supports many-to-one, as well as one-to-one connections over LANs and WANs. *Norton-Lambert Corp., PO Box 4085, Santa Barbara, CA 93140.*

CIRCLE NO. 23 ON FREE CARD

Windows File Viewer

Mastersoft's Viewer 3.1 file-viewing utility for *Windows* 3.1 enables you to view formatted files in more than 120 formats, without requiring the source applications. Viewing features include zoom, print from view, copy to clipboard,

(Continued on page 112)

By TJ Byers

Enhanced IDE: Dispelling the Myths and Rumors

IDE changes to meet the challenges of today's fast DX2, DX4 and Pentium systems

So much murk and myth surround the Enhanced IDE, or EIDE, interface that it's difficult to sort fact from fiction. For example, according to some reports, you can install IDE CD-ROM drives only in a system that has EIDE built into the motherboard. Another popular myth is that you need a local-bus system to take advantage of EIDE. Both rumors are patently bunk.

Enhanced IDE is an ANSI (American National Standards Institute) standard spearheaded by Western Digital that offers the following potential advantages over ordinary IDE:

(1) Larger drive capacity of up to 8.4G

(2) Faster data transfer rates of up to 16.6M/s

(3) Support for CD-ROM and tape drives

(4) Support for four or more IDE devices

EIDE is a backward-compatible standard, which means that you can connect an EIDE drive to an old IDE interface and *vice-versa*. To obtain any of EIDE's benefits, though, you must have an EIDE interface, and to obtain the speed enhancements, you need an EIDE drive.

If you need both EIDE and SCSI and don't have a lot of expansion slots or need the hassle of conflicting controllers, the answer could be Adaptec's TotalAdvantage VL. This card plugs into a single VESA local-bus slot and supports seven SCSI devices, two EIDE drives, two floppy drives and a QIC-80 tape drive, for a total of 12 devices.

IDE Beginnings

The first hard-disk interface for the PC, the ST-506, was designed by Shugart Associates, an early leading supplier of hard-disk drives. At that time, all the circuitry needed to operate the hard disk was located on an adapter card (called a controller) that plugged into an expansion slot on a PC's motherboard. Separate ribbon cables for control signals and data signals linked the hard-disk drive to the controller.

Unfortunately, the ST-506 transferred data serially, one bit at a time, which placed severe limitations on the data-transfer rate that could be achieved by this system. In 1986, Compaq Computer, Conner and Western Digital defined a parallel interface that improved the hard disk's data-transfer rate many-fold.

Based on the original ST-506 control signals, the new standard specified a BIOS and software interface that moved the electronics from the controller card to the hard-disk drive. Dubbed IDE, which is short for Integrated Drive Electronics, the interface was reduced to a single ribbon cable that connected to the I/O bus used by the motherboard's expansion slots. Because an external controller card was no longer needed, the IDE interface soon became a part of the motherboard in the form of a single connector.

The *de-facto* IDE standard soon found itself the topic of an ANSI standards committee, where the interface was linked with the design and manufacturing of the hard-disk drive. Specifically, the ATA specification defines the drive's characteristics for the physical interface, command definitions and electrical signals.

The specification provides no definition for the host controller. The IDE interface is simply a vehicle for transfer of data to and from the ATA drive. What's accomplished, though, is that one driver (usually embedded in the BIOS) will properly address any IDE

hard disk using a common set of commands and signals, making IDE an early form of plug and play.

Enhanced IDE

As hard-disk technology advanced, it became painfully apparent that the ATA standard lacked the resources needed to address the issues of larger disk capacity and increased data throughput. This led to the formulation of ATA-2, which is the Enhanced IDE, or EIDE, specification.

ATA-2's first challenge was to break the 528M barrier imposed by the original IDE specification. The maximum capacity of a hard disk is determined by such factors as the maximum number of cylinders, heads and sectors the BIOS and IDE protocol can address (Table 1). Maximum ATA hard-disk capacity is determined by the lowest denominators of the BIOS and IDE specifications—which is why ATA tops out at 528M.

A requirement of the new ATA-2 specification is compatibility with the large base of installed IDE drives. This means any changes made in addressing mode must be transparent to standard IDE drives. EIDE solves this problem by adding an extension to the operating system's hard-disk interrupt code, via software like Ontrack's *Disk Manager,* or the BIOS. Adding an extension to the interrupt code (INT 13h, to be exact) extends EIDE hard-disk capacity to 8.4G while maintaining compatibility with standard IDE drives.

The foregoing is possible because of the way the system views the inside of an IDE disk drive. The cylinder, head and sector values you see in Table 1 aren't real values—they're translations. The actual IDE hard-disk platter is formatted altogether differently, with a lot fewer heads and many more cylinders and sectors per track. Because the system must perform a translation, you're at liberty to modify the translation code without upsetting the apple cart. The LBA (Logical Block Addressing) method, as it's called, permits sectors on the drive to be addressed by cylinder, head and sectors or by using a single 28-bit logical block address that avoids cylinder/head/sector conversions.

The IDE drive has taken a lot of criticism over the years because of its slow data-transfer rate. When used with a basic IDE "paddlecard" plugged into an ISA slot, the IDE drive has a data-transfer rate of about 1.5M per second (M/s).

Table 1. Maximum Capacities of Hard-Disk Drives

Maximum Values	BIOS	IDE Specification	ATA
Sectors per Track	63	255	63
Number of Heads	255	16	16
Number of Cylinders	1,024	65,536	1,024
Hard Disk Capacity	8.4G	136.9G	528M

Maximum IDE hard-disk capacity is determined by lowest common denominator of BIOS and IDE specifications, or 528M. EIDE extends capacity to 8.4G by adding an extension to hard disk's interrupt code.

Table 2. Maximum Data-Transfer Rates for ATA Modes

ANSI Specification	Common Usage	PIO Mode	DTR (M/s)	DMA Mode	DTR (M/s)
ATA	IDE	0	3.3		
ATA	IDE	1	5.2		
ATA	IDE	2	8.3		
ATA-2	EIDE/Fast ATA	3	11.1	1	13.3
ATA-2	Fast ATA-2	4	16.6	2	16.6
ATA-3	Fast ATA-3	5	20	TBA	TBA

A number of leading PC, disk-drive and BIOS manufacturers, spearheaded by Western Digital, are revamping IDE specification so that new IDE drives will be fast enough and large enough in capacity to keep up with DX2, DX4 and Pentium systems.

With the ATA specification came an electrical standard that defines signal-sequence and timing parameters for the hard-disk drive. These timings are grouped together in a set called a Programmed Input/Output (PIO) Mode. In the ATA specification, PIO Mode defines the speed of the hard drive—not the interface. The ATA specification defines Modes 0, 1 and 2. Maximum data-transfer rates for these modes are 3.3M/s, 5.2M/s and 8.3M/s, respectively, as detailed in Table 2.

Because of a quirk in the way the ATA standard defines data-transfer rate, the maximum value specified is actually a minimum value. In other words, the hard disk must be able to support the maximum data rate. This means the drive is often quite faster than it appears to be. For example, if a drive is 1 ns short of meeting the Mode 2 specification, it's branded Mode 1. Some EIDE controllers are able to read the actual data-transfer rate from the drive, which it can use in certain situations to improve performance.

Also built into the ATA standard are commands that permit the hard disk to do multiple read/write operations for faster data throughput. Also known as multiple block size (MBS) and Block Mode, the multiple read/write mode can improve data throughput by as much as 80%. These commands have been supported by most hard-drive vendors for some time, usually in drives with capacities greater than 200M. Prior to EIDE, these commands were used by IDE disk accelerator cards and software programs like Ontrack's *Drive Rocket* to improve IDE performance.

The ATA-2 standard defines PIO Modes 3 and 4. Modes 3 and 4 are new protocols that give the disk drive (not the CPU) control over data transfers. Mode 3 can transfer data up to 11.1M/s, and Mode 4 can transfer data up to 16.6M/s. In committee is PIO Mode 5, which it's hoped will push the data-transfer rate to 20M/s.

The EIDE interface can transfer data by two methods: PIO and DMA (Direct Memory Access). The PIO method requires CPU intervention, which consumes CPU time and clock cycles. In DMA mode, data goes directly from hard disk to system memory under control of a DMA controller, thereby freeing the CPU for other chores and improving throughput.

EIDE architecture provides for two DMA channels. DMA Mode 1 has a data-transfer rate of 13.3M/s, DMA Mode 2 16.6M/s. They're both assigned to the ATA-2 specification and are often equated with PIO Modes 3 and 4, respectively. Future versions of

Table 3. Speeds of Most-Popular CPUs and Relative Motherboard Speeds

CPU Type	CPU Clock*	Local Bus Speed*
386DX-33	33	33
386DX-40	40	40
486SX-25	25	25
486DX-25	25	25
486SX-33	33	33
486DX-33	33	33
486DX-50	50	50
486SX2-50	50	25
486DX2-50	50	25
486SX2-66	66	33
486DX2-66	66	33
486DX4-75	75	25
486DX4-83	83	28
486DX4-100	100	33
NextGen Nx586-75	75	25
NextGen Nx586-80	80	27
NextGen Nx586-90	90	30
NextGen Nx586-100	100	33
Pentium 60	60	30
Pentium 66	66	33
Pentium 75	75	25
Pentium 90	90	30
Pentium 100	100	33
Pentium 120	120	40

*MHz.

To obtain maximum performance from EIDE, controller must match drive's performance to that of bus. Keep in mind that speed of local bus is equal to clock speed of motherboard, not clock speed of CPU, which often runs two to three times faster.

Table 4. Data-Transfer Rates for Bus Speeds From 8 MHz Through 50 MHz

Bus Clock*	Cycle Period**	Maximum DTR***	Closest EIDE Mode
8	500	5.0	PIO Mode 1
20	200	10.0	
25	180	11.3	PIO Mode 3
30	160	12.5	
33	150	13.3	DMA Mode 3
40	125	16.0	
50	120	16.6	PIO Mode 4

*MHz; **ns; ***M/s

To achieve maximum Mode 4 data-transfer rate of 16.6M/s, bus speed must be 50 MHz, which very few PCs support. Most PCs have 33-MHz bus clock, which matches data-transfer rate of DMA Mode 3.

EIDE will implement faster DMA modes for use with Mode 5 and beyond. In fact, EIDE communication faster than 20M/s will require DMA operation. PIO is simply not responsive enough.

Visualize a car (packet of data) cruising down a data highway (EIDE bus). Like all roadways, there are traffic lights along the way that control the flow of traffic. Green means go, red stop. In the PIO world of data control, there are only red lights. What occurs is that if the system isn't ready to accept the data (usually a busy signal from the CPU), a red light is flashed and the process comes to a screeching halt (as in both feet on the brake pedal). The hard disk then regroups and tries again.

In DMA mode, the data packet is loaded aboard the car, and the car is positioned on the starting line, dragster style. When the light turns green, signaling that the system is ready for the data, the accelerator is punched and the data is off like a shot—no red lights, no yellow caution flags, simply pedal to the metal all the way.

Unlike ATA data-transfer rates, ATA-2 rates actually represent the *theoretical* maximum possible data rate with the hard-disk drive. This means you're not likely to push the drive past its specified limits as you can with ATA drives.

Before you become confused between EIDE DMA channels and the DMA channels you find on a PC's motherboard, keep in mind that they aren't the same. EIDE DMA channels are a part of the EIDE chipset and are reserved for only EIDE use.

ISA, VL & PCI

Having a fast hard disk is no guarantee you can achieve advertised speed. Maximum data-transfer rate for the EIDE specification deals with the hard disk only—not the actual data throughput, which may be quite different. For example, a Mode 2 hard disk plugged into an ISA slot will probably never see 8.3M/s. Most likely, it will run somewhere between 3M/s and 5M/s, depending on the configuration of the system and interface card type. The three IDE connector types are ISA, VL (or VESA) and PCI.

The ISA connector is common to virtually all PC systems. Originally designed for use in the IBM PC/AT, the ISA socket is a 16-bit expansion slot located on the motherboard. This slot can be used for a wide variety of peripherals, like a video card, an internal modem or an EIDE interface. The ISA slot typically runs at 8 MHz, which translates into a maximum sustained data-transfer rate of about 5M/s.

To run at speeds faster than 5M/s, you must plug into the local bus. Both VL and PCI are local-bus slots that run at the same speed as the motherboard. The speed of the motherboard is based on the speed of the CPU. For example, a 486SX-25 motherboard runs at 25 MHz. Don't be fooled by clock-doubler or tripler chips. Although the 486DX2-66 runs at 66 MHz, the motherboard runs at only 33 MHz, which is half the speed of the CPU. The same applies to the 486-DX4-100, which is a clock tripler. Table 3 details the speeds of the most-popular CPUs and their related motherboard speeds.

To obtain top performance from EIDE, you need to match the local-bus speed with the timing requirements of the drive. For example, to obtain 16.6M/s data throughput in Mode 4, the local-bus clock frequency must be 50 MHz. Maximum data-transfer rate for a 33-MHz local bus, the most popular motherboard speed, is 13.3M/s. Table 4 enumerates the data-transfer rates for bus speeds from 8 MHz through 50 MHz.

EIDE Cable Length

As the speed of EIDE increases, the length of the interface cable decreases. While this is typical of any interface cable, parallel or serial, EIDE is more restrictive than most. Unlike most communication cables, the length of an EIDE interface cable is measured in inches, not feet. Maximum cable length for a Mode 3 drive running at 11.1M/s is just 18". Compare this to 20 feet for a SCSI interface running at approximately the same speed, and you begin to appreciate the problem.

The reasons for the short cable lengths are many. Basically, though, short cable length has to do with the electrical properties of EIDE.

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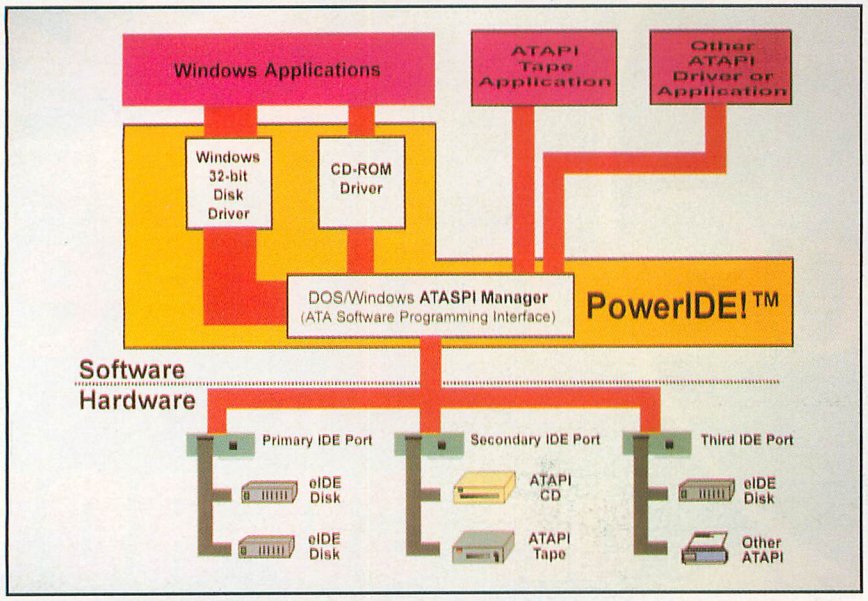


Fig. 1. ATAPI-compliance doesn't guarantee you can mix and match IDE and EIDE devices in a system. ATAPI is just a communication protocol. To prevent an ATAPI tape drive from stepping on the toes of a CD-ROM, you need a drive manager, like the ATASPI Manager in Future Domain's *PowerIDE!*

produces a sharp wavefront that's rich in high-frequency harmonics. When these high frequencies reach the end of the cable, some of the energy is reflected backward, rather than being absorbed at the receiving end. These reflections interfere with subsequent signals coming down the pipeline, causing them to distort in shape and amplitude.

Think of it as tossing a rock into a small pond, and watching the outermost ripples bounce off the rocks and start back toward the source, interfering with the source's inner ripples that are still heading outward. Instead of a clean, concentric pattern of waves, you end up with a mixed bag of crossing patterns.

Local-Bus Myth

A common myth surrounding EIDE is that you need a local bus to gain from the technology. Not true. Although data throughput is the name of the game, most-hard disk drives—even those compliant with Mode 3 and Mode 4—seldom run flat out for any length of time. Most data-transfer operations spend more time locating data than they do moving it from one place to another. This is why the ISA interface is quite acceptable for many applications. Keep in mind that while ISA is slower than local-bus data transfers, it's still two to three times faster than straight IDE.

The solution to the foregoing is to use an impedance-terminated cable (basically a fixed-impedance transmission line with resistor termination), which essentially prevents reflected waves. The alternative is to keep the cable to a length short enough that the reflected waves die out before another wavefront begins.

SCSI uses impedance-terminated cables, whereas EIDE limits the length of the cable. While the latter is a less-expensive solution, it prevents an EIDE drive from being installed outside a computer's system unit. This explains why all EIDE drives are internal devices.

With the advent of 20M/s EIDE drives looming on the horizon, the prospect of successfully tying together these drives with 12"-long and shorter cables isn't inviting. The ATA-3 committee is working on this problem for defining the electrical properties of Mode 5. While more expensive, it appears the new specification may include at least some elements of defined-impedance transmission lines with termination.

The struggle is to define a cable that's compatible with ATA-1 and ATA-2. If this barrier can be successfully bridged, future implementations of EIDE may see external peripherals.

Adding CD-ROM

The proliferation of multimedia CD-ROM-based software has led the industry to search for ways to reduce the cost of CD-ROM drives to further encourage growth in this burgeoning market. An attractive solution is to attach the CD-ROM drive to the empty IDE socket available in most PCs.

If an IDE port already exists to support a second hard drive, the cost of a

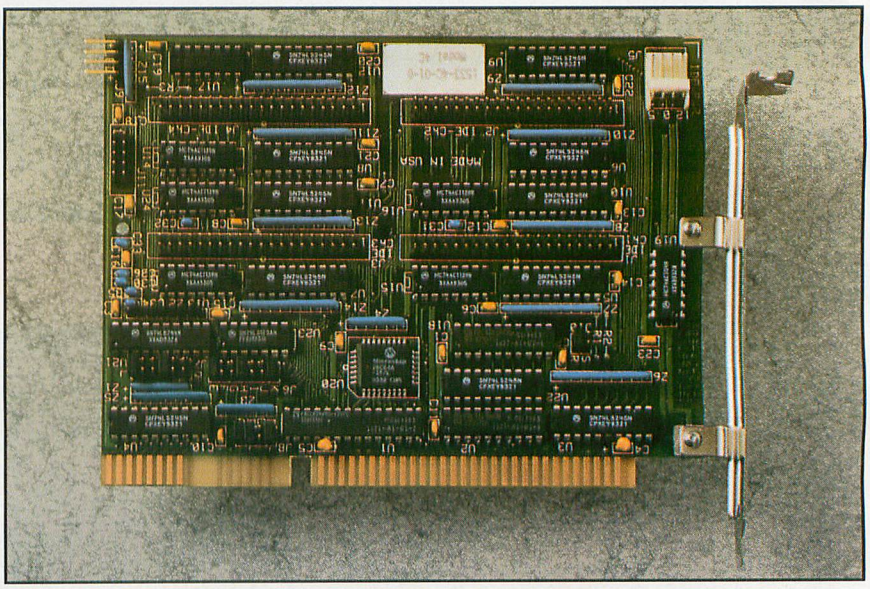


Fig. 2. The ATA-2 specification expands device count from two to four by adding a second channel to the interface. Most EIDE interface cards can coexist with the current IDE interface, for a total of six drives. If this still isn't enough, consider GSI's Model 4C, which brings eight-device multi-channeling IDE to the desktop.

CD-ROM attachment is virtually free because additional interface hardware isn't required, as is the case with SCSI and proprietary CD-ROM drives that require special controllers.

Addressing this area of non-hard drives is ATAPI, the AT Attachment Packet Interface. Basically, ATAPI is a communication protocol that spells out a set of instructions to make a CD-ROM jump though hoops and perform. ATAPI uses the ATA-2 physical and electrical specifications, but it adds to the command set in the same way Block Mode (multiple read/write) commands were added to the IDE interface when defining the ATA standard. ATAPI isn't limited to CD-ROM drives. It can work just as well for a tape drive, a scanner or any other IDE device.

The current ATAPI specification for CD-ROM drives is in wide use by a number of vendors, and quite successfully. The specifications are being forwarded to ANSI for inclusion in ATA-3. However, ATAPI, by itself, isn't enough to handle multiple IDE devices. After all, it's just a protocol. To mix IDE devices you need a device manager, like the proposed ATASPI (ATA Software Programming Interface) Manager found in *PowerIDE!* from Future Domain. ATASPI is middle-management software that's positioned between the software application drivers and the EIDE interface card (Fig. 1).

Room To Grow

The original IDE interface allowed for two hard-disk drives running on the same data cable. This is done by separating the two drives into a master drive and a slave drive, where boot drive C: is assigned as a master and the second drive, if any, becomes the slave. The advantage of this arrangement is that it's easy to select between the two drives for data transfer using simple logic built into the interface electronics.

EIDE maintains the master/slave concept because of its simplicity, and it fits with the backward compatibility concept set forth when first defining the ATA-2 standard. Unfortunately, this arrangement has two rather serious drawbacks.

The first drawback is that one empty drive interface isn't nearly enough for a fully-configured multimedia system. At the least, you need one each hard-disk and CD-ROM drives. This leaves no room for expansion to include a second CD-ROM drive, tape drive or scanner. To compete with more-robust interfaces like SCSI, the drive count must be expanded to at least four devices.

The answer Western Digital *et al* decided on is eloquently simple: add another channel to the interface. Like the first channel, the second data channel is structured using master/slave architecture, giving EIDE the capability to support up to four devices. To distinguish between the two, the primary channel is assigned IRQ14, and the second channel uses the IRQ15 interrupt.

Off To The Races:Enhanced IDE Vs. SCSI

With a complete makeover under its belt, Enhanced IDE's new numbers are quite impressive. So impressive are they, in fact, that they rival those of SCSI—until now, the undisputed king of speed. Well, there's nothing like a good old foot race to find out who's faster.

The runners take to the starting blocks, each determined to be the first to break the tape in a dash for the gold. SCSI looks nervous as Enhanced IDE beams a smile of victory, knowing full well this short sprint is a cakewalk for him.

But wait, it looks like there's a last minute rule change. *Windows 95* is conferring with the judges. And...it's official. Each runner will have to juggle three balls as he jogs around the track. Beads of sweat drip from Enhanced IDE's brow, as the starter's pistol is raised head high. There's the shot, and they're off!

Enhanced IDE takes the early lead, but what is this? He's tossing only one ball in the air. Must have accidentally left the other two at the starting line. From the sidelines comes a software driver, who hands Enhanced IDE two more balls. SCSI takes the lead while Enhanced IDE stops to master the art of juggling. He's getting the hang of it, looking better, and...Enhanced IDE is off to the races again.

Meanwhile, SCSI has a substantial lead over Enhanced IDE, and is rounding the first turn. Here comes Enhanced IDE into the turn, looking a bit unsure of himself. Seems a bit wobbly as he makes the turn, and...Enhanced IDE has dropped all three balls! Quickly, another software driver rushes onto the track and picks up the fallen balls. The driver is whispering something into Enhanced IDE's ear, he nods knowingly, and he's off again. I see only one ball in the air, though. There goes the second.

Enhanced IDE rounds the turn and heads into the back straight. The third ball is finally in the air. Enhanced IDE seems much more confident and is gaining on SCSI, who is heading into the far turn.

Oops! Enhanced IDE has dropped one of the balls, but he doesn't appear to be stopping to retrieve it. No, he's turning up the speed and is gaining ground quickly. In the far turn now, and there goes another ball to the ground. I don't know how you saw it, fans, but it looked like Enhanced IDE purposely threw that ball to the ground.

Enhanced IDE is pouring it on in a single burst of blinding speed. He's gaining, now passing SCSI. He crosses the finish line steps ahead of SCSI. Enhanced IDE has won the race, but with only one ball in hand. Here comes SCSI across the finish line, still juggling all three balls.

Well, I don't how to call this one. There's no doubt Enhanced IDE is faster than SCSI if there's only one ball to juggle, making it ideal for a lot of desktop applications like desktop publishing and number crunching. If I were in a multi-user, multitasking environment running *Windows 95*, though, I'd put my money on SCSI. And there you have it, fans. Who would you put your money on?

Transfer Rates for IDE & SCSI Interfaces

Protocol	Bus Width*	Maximum DTR**
ATA PIO Mode 0	16	3.3
SCSI-1	8	5.0
ATA PIO Mode 1	16	5.2
ATA PIO Mode 2	16	8.3
Fast SCSI-2	8	10.0
ATA-2 Mode 3	32	11.1
ATA-2 Mode 4	32	16.6
Fast Wide SCSI	16	20.0
ATA-3 Mode 5	32	20.0

*Bits; **M/s

EIDE is best choice for single-user systems because it offers high transfer rates, expanded connectivity, and support of larger drive capacities. SCSI is best choice for multi-user, multithread systems like *Windows 95* because it offers support for larger number and variety of peripherals, including removable media drives and scanners.

EIDE Interface Adapter Buyer's Guide

Product	Vendor	Price ($)	Bus Type	PIO Mode	BIOS	Drives	Floppy.	I/O PortS	Cache	OperatingSystem**
TotalAdvantage VL	Adaptec	199	VL	0,3,4	No	2	Yes	None	No	D,W,O,N
ACD-rom	ARCO	47	VL	0 to 3	Y	4	Yes	2S,EPP	No	D,W,O,N
VL-Pro 6212	CMD	74	VL	0,3,4	N	4	Yes	2S,1P,G	No	W
CSA 6213	CMD	69	VL	0,3,4	N	4	Yes	2S,1P	No	W
CSA 6222	CMD	99	VL	0,3,4	No	4	Yes	2S,EPP,G	No	W
PCI-Pro 6400	CMD	49	PCI	0,3,4	No	4	No	None	No	W
PCI-Pro Plus 6401	CMD	94	PCI	0,3,4	No	4	Yes	2S,EPP,G	No	W
CSA 6460	CMD	TBA	PCI	0,3,4	No	4	TBA	TBA	No	W
DTC 1181	DTC	25	Eight-Bit ISA	N.A.	Yes	N.A.	N/A	N.A.	N.A.	N.A.
DTC 2183	DTC	15	ISA	0	No	2	No	None	No	D,W,O,N
DTC 2280E	DTC	39	ISA	0	No	2	No	2S,EPP,G	No	D,W,O,N
DTC 2188	DTC	19	ISA	0	No	2	No	None	No	D
DTC2278EB	DTC	89	VL	0 to 4	Yes	4	Yes	2S,EPP,G	16M	D,W,O,N
DTC 2277	DTC	249	VL	0 to 4	No	4	Yes	None	16M	D,W,O,N,U
DTC 2130D	DTC	39	PCI	0 to 4	No	4	No	None	No	D,W,O,N
DTC 2132	DTC	99	PCI	0 to 4	No	4	No	None	No	D,W,O,N,U
The IDE CD-ROM Kit	Future	28	ISA	0	No	2	No	None	No	D,W
IDE-AT ValuePak	Future	55	ISA	0	Yes	4	No	None	No	D,W,
IDE-VL ValuePak	Future	99	VL	0 to 3	No	4	Yes	2S,EPP,G	No	D,W
Model 18	GSI	47	ISA	0 to 3	Yes*	2	No	None	No	D,W,O,N
Model 21	GSI	59	ISA	0 to 3	Yes*	2	Yes	None	No	D,W,O,N
Model 32	GSI	115	ISA	0 to 3	Yes*	2	Yes	2S,EPP	No	D,W,O,N
Model 4C	GSI	135	ISA	0 to 3	Yes*	8	No	None	No	D,W,O,N
1645-V1	GSI	80	VL	1 to 4	NA.	2	N.A.	N.A.	No	N.A.
1645-V2	GSI	119	VL	1 to 4	N.A.	4	N.A.	N.A.	No	N.A.
DC5030	Promise	179	PCI	N.A.	Yes	4	No	None	16M	D,W,O,N,U
DC4030	Promise	169	VL	N.A.	Yes	4	Yes	None	16M	D,W,O,N,U
EIDE4030plus	Promise	179	VL	N.A.	Yes	6	Yes	2S,EPP,G	16M	D,W,O,N,U
DC200	Promise	149	ISA	N.A.	Yes	4	Yes	None	16M	D,W,O,N,U
EIDE2300plus	Promise	60	VL	0 to 4	Yes	4	Yes	2S,EPP,G	No	D,W,O,N,U
EIDEMAX	Promise	29	ISA	0	Yes	2	No	None	No	D,W,O,N

*Flash BIOS **D = DOS; W = *Windows*; O = OS/2; N = Novell; U = Unix

As a rule, the first channel is used exclusively for hard-disk drives, and the second channel is used for slower peripherals like CD-ROM and tape drives. The reason for this addresses the second major shortcoming of EIDE master/slave architecture.

Let's say you have a Mode 0 hard disk installed as the master IDE device and then add a Mode 3 hard disk in the slave location. One is a fast device, the other a slowpoke. The problem occurs when the interface tries to communicate with the disk drives. If the interface communicates as fast as the Mode 3 drive, the slower Mode 0 drive can't keep up with the conversation and gets confused. This leads to erratic behavior on the part of the slower drive, which can crash the system.

To avoid the problem, the EIDE interface automatically adjusts itself to the speed of the slowest device on the channel. As you can see, pairing a slow CD-ROM drive with a fast hard drive would bring a potentially fast system to a crawl. By placing the slower drives on their own separate channel, the hard-disk drives are permitted to run at full speed.

Vendors like DTC Data Technol ogy circumvent this issue altogether by mapping the speed of the different devices and their locations on the channel. When the interface needs to communicate with a specific device, like a CD-ROM drive, it can single it out and shift gears to match its speed without disturbing the other drive on that channel. Of course, this prevents the possibility of multitasking because it addresses only one drive at a time, but then EIDE wasn't intended to be a multitasking interface.

While four devices may seem like plenty, they run out faster than you think. Fortunately, there's nothing in the EIDE specifications that states there can't be more than four IDE devices. Several EIDE controllers can handle six drives using three channels, and one, the GSI Model 4C, supports eight EIDE drives on four channels (Fig. 2). The downside to adding more channels is that each channel needs its own interrupt and I/O address. In the case of the GSI Model 4C, Channels 3 and 4 use IRQ12 or IRQ11 (the same used by some sound cards) and IRQ10 or IRQ9 (the same IRQs NetWare supports), respectively. In a crowded system that has a lot of multimedia peripherals, there may not be enough interrupts to go around.

Software Drivers or BIOS?

As you may already suspect, there's more to installing an EIDE drive than plugging an EIDE interface card into an ISA or local-bus slot on a motherboard. Unless you bought your PC within the last six months, it's a safe bet the BIOS has never heard of Enhanced IDE, much less supports it. Two ways to get your PC to recognize an EIDE drive are: software drivers and an on-board BIOS chip.

About half the EIDE interface cards on the market use software drivers because they're inexpensive and flexible. They're inexpensive because the only cost is a floppy disk, and they're flexible because updating a driver is a keystroke away. But be prepared to do a fair amount of installation setup because each function requires a separate driver. For example, there's an LBA driver that breaks through the 528M barrier, an ATAPI driver for the CD-ROM drive and another driver for *Windows* 32-bit access—plus a driver to select PIO mode. Multi-channeling, four or more EIDE devices, can add another driver to the lot.

Generally, these drivers are TSR utilities that take up residency in system RAM. Not only do TSRs steal memory away from the system, they also have the potential to conflict with system functions and other applications.

Interface cards with built-in BIOS are faster and a lot easier to install.

Glossary of Technical Terms

ATA (AT Attachment). Protocol used to transfer data, status and control information between a PC and an IDE or EIDE hard-disk drive.
ATAPI (AT Attachment Packet Interface). Command set attachment to ATA protocol used to address and control non-disk IDE peripherals, like CD-ROM and tape drives.
ATASPI (ATA Software Programming Interface). Software-oriented interface, located between EIDE hardware and application drivers, that manages data flow between system and attached peripherals.
BIOS (Basic Input/Output System). A small quantity of code used for controlling basic computer functions, such as keyboard, disk drives and video.
Block Mode. See Multiple read/write.
DMA (Direct Memory Access). A specialized controller that lets an expansion card, disk drive and other devices access system memory, without involving the CPU.
EIDE (Enhanced Integrated Drive Electronics). A recent augmentation of the IDE standard that increases hard-disk capacity to 8.4G, supports data rate transfer speeds up to 16.6M/s, recognizes CD-ROM and tape drives and extends number of attached devices from two to four.
IDE (Integrated Drive Electronics). A *de-facto* protocol jointly developed by Compaq Computer, Conner and Western Digital in 1986 that defines a parallel hard-disk interface. ANSI committee adopted IDE guidelines and expanded on them to create ATA standard.
ISA (Industry Standard Architecture). Bus structure that defines signals and timing for IBM PC and IBM PC/AT adapter-card interface socket. ISA is most popular expansion slot and is found on virtually all motherboards.
LBA (Logical Block Address). A method of addressing hard-disk drives larger than 528M in capacity. Allows sectors on drive to be addressed by cylinder, head and sectors or using a single 28-bit logical block address.
MBS (multiple Block Size). See Multiple read/write.
Multiple Read/Write. Ability to perform efficient I/O transferring multiple blocks of data while interrupting CPU only one time. Without this feature, an interrupt is generated to alert CPU that it has to process next sector of data.
Multitasking. Ability to deal with more than one application at a time.
Multithreading. Ability to run two programs at the same time in realtime. Not same as time slicing, which is a multiplexed sharing of computer resources.
PCI (Peripheral Component Interconnect). Fast local-bus standard that runs at 33 MHz and supports 32- and 64-bit data paths. PCI is common in 486DX4 and Pentium systems and is also used in many 486 and 486DX2 computers.
PIO (Programmed Input/Output). An ATA protocol where CPU is involved in every data transfer between hard disk and system memory.
VL Bus. Short for Vesa Local Bus and is a popular local-bus expansion slot found in many 486 and 486DX2 computers. Runs at speeds up to 66 MHz and sports 32-bit data path.

Where To Buy

Adaptec, Inc.
691 S. Milpitas Blvd.
Milpitas, CA 95035
Tel.: 800-442-7274

CIRCLE NO. 160 ON FREE INFORMATION CARD

ARCO Computer Products, Inc.
2750 N. 29 Ave. S-316
Hollywood, FL 33020
Tel.: 305-925-2688

CIRCLE NO. 161 ON FREE INFORMATION CARD

CMD Technology, Inc.
1 Vanderbilt
Irvine, CA 92718
Tel.: 800-426-3832

CIRCLE NO. 162 ON FREE INFORMATION CARD

DTC Data Technology Corp.
1515 Centre Point Dr.
Milpitas, CA 95035
Tel.: 408-942-4000

CIRCLE NO. 163 ON FREE INFORMATION CARD

Future Domain
2801 McGraw Ave.
Irvine, CA 92714
Tel.: 714-253-0400

CIRCLE NO. 167 ON FREE INFORMATION CARD

GSI
17951-H Sky Park Cir.
Irvine, CA 92714
Tel.: 800-486-7800

CIRCLE NO. 164 ON FREE INFORMATION CARD

Ontrack Computer Systems
6321 Bury Dr.
Eden Prairie, MN 55346
Tel.: 800-752-1333

CIRCLE NO. 165 ON FREE INFORMATION CARD

Promise Technology, Inc.
1460 Koll Cir.
San Jose, CA 95112
Tel.: 800-888-0245

CIRCLE NO. 166 ON FREE INFORMATION CARD

Like the CMOS setup table found in PCs, the IDE BIOS lists the various drive types supported and automatically installs them. Some have automatic setup routines that have the BIOS query the drive as to size and type and uses the information obtained to configure the setup. This eliminates having to sort through head, cylinder and sector tables. Usually, the ATAPI driver is embedded in the BIOS as well.

As a rule, BIOS-based interface cards also support a broader range of operating systems, like *Windows 95*, OS/2, *Unix* and *Novell*. The downside is that as the technology changes, a BIOS upgrade is needed. Frequently, it's less expensive to buy a new interface card than to pay for a new BIOS chip—unless you're lucky enough to have a flash BIOS like that found on all GSI boards. Unlike ROM BIOS, flash BIOS can be reprogrammed with the latest EIDE specifications via a floppy disk or downloaded BBS file.

Summing Up

To recap, the goal of Enhanced IDE is to advance the technology through four avenues: support for hard drives with greater than 528M capacity, increased data throughput, support for CD-ROM and tape drives and the ability to install four or more IDE drives in one system. As applications continue to push for larger disk space and faster peripherals, the EIDE specifications will, no doubt, change to meet the increasing demands at substantially lower cost than competitive technologies.

By Joe Desposito

Fixing PC Problems

Hardware and software products that can help you get an ailing PC back up and running

The more you know about a PC, the better are your chances of correcting problems that can occur with it. Hardware and software diagnostic tools can assist you in this endeavor.

A personal computer is a complex piece of equipment. It's composed of such key subsystems as a motherboard, memory, power supply, disk drives, keyboard and video monitor. As reliable as PCs are, a variety of ills can afflict any and all of these subsystems. When you throw into the mix operating-system software, you add another layer of complexity and invite more potential problems.

How can you hope to cope with the problems the hardware, software and operating system may present? The first thing to do is educate yourself as much as possible regarding the inner workings of personal computers and operating systems. Next, take notice of the software and hardware diagnostic products that are available.

In this article, I present several items that, hopefully, will raise your diagnostics consciousness and your knowledge of the inner workings of the PC. First I present a selection of hardware diagnostic tools for both comprehensive testing and more-specific tests. Then I present a selection of software diagnostic tools, some that are operating-system-independent, others that run under DOS and still others that run under Microsoft *Windows*. Like the hardware, the software is for both comprehensive testing and more-specific tests. I wrap up everything with a buyer's guide table for all of these products.

Who are these products for? For the most part, they're targeted at professional computer service people and those people who deal with large numbers of computers, such as a computer support staffs in a large organizations and value-added resellers (VARs). Some products, however, are directed to individuals who want to keep their systems running in top condition and to fix them themselves if anything goes awry.

Hardware

When repairing PCs, most people follow a test-and-toss approach in which they troubleshoot the problem to one of the major components of the PC and then toss out that component. Replacement components aren't too expensive, likely costing less than $100. If a replacement costs more, it probably qualifies as an upgrade and justifies the cost of the "repair." An example of a less-than-$100 replacement part is a floppy-disk drive.

An example of a more-costly replacement part is a motherboard, which can cost anywhere from several hundred dollars to more than $1,000. But if you replace a 386SX-20 motherboard with a 486DX-100, you've repaired the system and upgraded it, too.

A variety of hardware tools are available to help you make the correct decision about what components to toss out. Some of these tools are broad in scope, such as POST-code diagnostic cards, while others test just one subsystem, such as a computer video monitor test instrument.

• ***POST-Code Diagnostic Cards.*** These cards range in price from $59 to $799. You plug this type of card into one of the expansion slots on a PC's motherboard and it displays the POST (Power-On Self-Test) codes the computer generates during the booting process. Generally, the more-expensive the device, the more it tells you about your computer.

With POST-code cards, documentation is important as well. Once you know a POST code, you must interpret it correctly. More-expensive products usually include more POST-code information in the documentation that accompanies them. If you service different kinds of computers, you must know the POST-code explanations for as many different BIOSes as possible.

POST-code cards are most helpful for making a quick determination of a problem, even if nothing seems to be

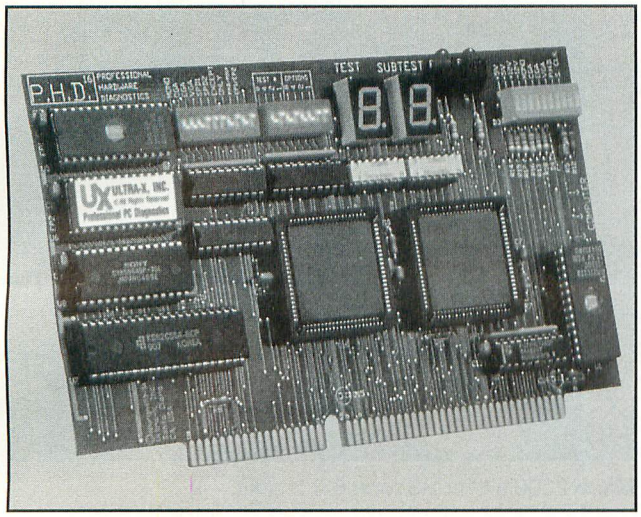
POST-Probe Hands On

Micro 2000's Universal Diagnostics Toolkit includes the POST-Probe, *Micro-Scope* Version 6.0 diagnostic software and a set of loopback plugs. I tried the POST-Probe on a 386SX-20 computer that had been giving me an FDD-controller error on boot-up. I had replaced the controller card, with no success. With help from the Micro 2000 technical support staff and the POST-Probe card, I discovered that the POST error was due to a keyboard controller chip failure.

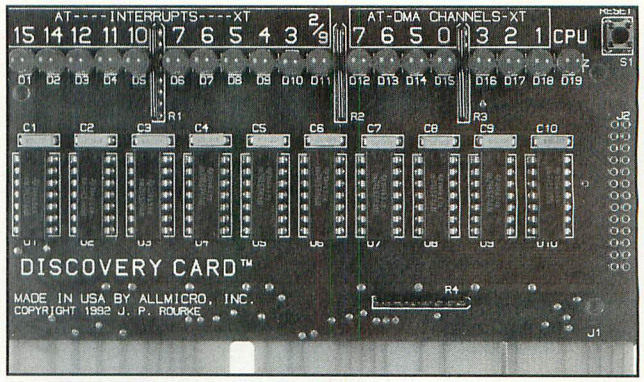
Tech support suggested that I replace the keyboard controller chip and remove the chip that contains the CMOS RAM (to clear the CMOS information). Since I didn't have an exact replacement for the keyboard controller chip on hand, I borrowed one from another computer.

After replacing the keyboard controller chip and plugging the CMOS RAM chip (P82C206 of the Chips and Technologies chipset for this model) back into its socket, I tried to boot the machine. Although I got a general type CMOS error, the FDD-controller error had disappeared and the computer booted up okay. Unfortunately, this was only a temporary fix. After re-booting the computer a few times, memory errors began to appear, which I couldn't resolve.

This experience points out how difficult it can be to repair motherboard-related problems. Not only do you need replacement parts, which may not be readily available, the POST codes don't always detect the root cause of a failure. In other words, I really didn't know what caused the keyboard controller chip to fail in the first place.



Ultra-X's P.H.D. card.



AllMicro's Discovery Card card.

working in a PC. The card may point to a problem on the motherboard, in main memory or in the power supply. In some cases, the card will indicate that a particular chip on the motherboard is defective. If the chip is socketed, replacing it might solve the problem and help you salvage the motherboard.

Post-code cards generally indicate POST codes on two seven-segment LED displays (see the "How POST Code Cards Work" box elsewhere in this article). Power-supply voltages (±12 volts and ±5 volts) are indicated with LEDs, as are signals like OSC (oscillator). If the voltage or signal is present, the LED is on; if not, it's off.

At $59, POST Code Master from MicroSystems Development is the least-expensive POST-code card listed in the Buyer's Guide in this article. An eight-bit card, POST Code Master indicates POST codes and power-supply voltages. The documentation provides information on the BIOSes of nine companies.

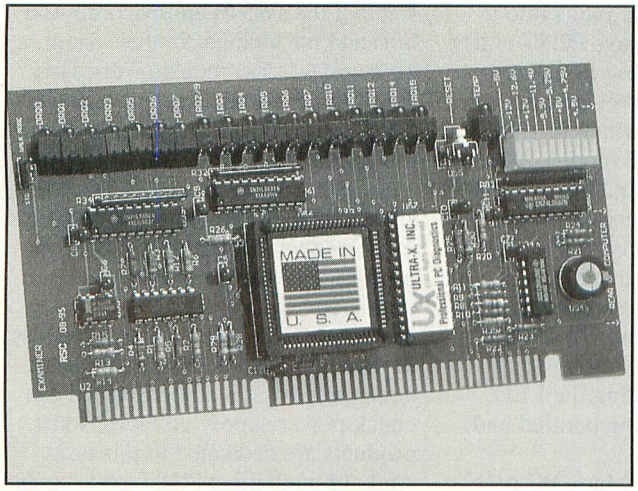
Among Data Depot's 17 diagnostic products (of which six are listed in the table), two are POST-code cards. The $299 PocketPOST V2 Test Card is an eight-bit POST card with a logic probe.

Data Depot's PocketPOST V2 indicates POST codes and power-supply voltages (present and within 95% of rated values). The probe monitors the status (HI, LO, actively toggling) of 10 bus signals—one at a time, depending on jumper settings. Test points on the board let you take precise power-supply voltage measurements. A 300-page manual includes code explanations from all the major BIOS manufacturers.

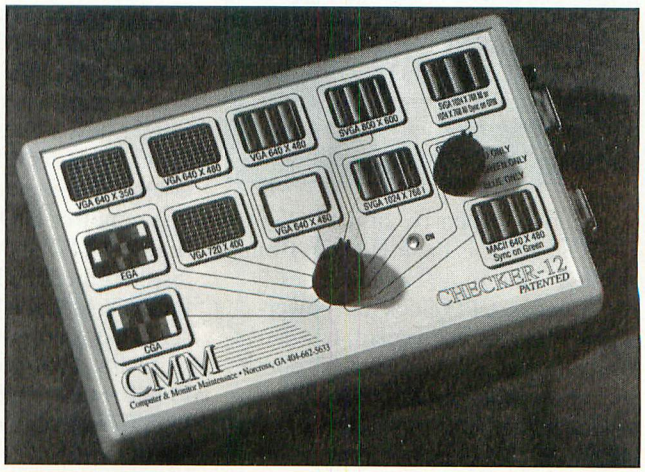
The $119 eight-bit Data Depot MiniPOST Test Card indicates POST codes and power-supply voltages.

In addition, Data Depot sells the $129 PocketPOST MCA Test Card, which is an adapter that lets the V2, MiniPOST and other POST-cards operate in a PC that has a MicroChannel bus. Data Depot is also working on two more POST cards designed specifically for the PCI bus, PCI POST and Configuration Master. Both cards are expected to be ready by the time this article appears.

Micro 2000's $399 POST-Probe is an eight-bit card that indicates POST codes, power-supply voltages and the status of eight bus signals. Test pads on the card allow you to take precise power-supply voltage measurements. Also included with the card are a tri-state logic probe and an adapter for MicroChannel computers. The POST-Probe manual includes POST-code explanations from 10 manufacturers. For more information on troubleshooting with this card see the "POST-Probe Hands On" box.



Ultra-X's Examiner card.



Computer & Monitor Maintenance's Checker-12 video monitor tester.

Sencore's CM125 Computer Monitor Signal Generator.

Micro 2000's Micro-Scope 6.0 test kit.

How POST Code Cards Work

POST is an acronym for Power-On Self-Test and is a procedure the BIOS (Basic Input/Output System) software of a PC performs when it's turned on. The BIOS checks, tests and initializes such various hardware components and subsystems as the keyboard controller chip and RAM. Before beginning each step, the BIOS writes a two-digit identifying code to an external address. This is commonly referred to as a POST code. When a test fails, the last POST code generated points to the failure.

Since IBM PCs and XTs don't generate POST codes, you can't troubleshoot these older computers with a POST-code diagnostic card. However, AT-class computers (with 80286 through Pentium CPUs) do generate POST codes. Unfortunately, POST codes have never been standardized. The explanations of the codes differ according to the BIOS manufacturer and version of BIOS in a given PC. To find out what a particular code means, you must refer to documentation that comes with the POST-code card. If your BIOS version isn't in the documentation, you must find out the explanations of the POST codes on your own.

The most-expensive of the POST cards, at $799, is the P.H.D. 16 from Ultra-X. This 16-bit card indicates POST codes, CPU clock and power-supply voltages on the card. If video is available, the card also displays component-level diagnostics and test results on the video monitor, providing information on defective components without having you look up error codes in a manual. P.H.D. 16 can also send test results to a printer. DIP switches on the card let you specify the particular diagnostic tests you wish to run.

Ultra-X sells two other POST-code cards that have the same ability to indicate POST codes and power-supply voltages and send diagnostic tests and results to a computer's video monitor. They're the $599 eight-bit R.A.C.E.R. II and the $599 R.A.C.E.R. PS/2 MicroChannel card.

The $195 eight-bit QuickPost-PC indicates POST codes and power-supply voltages and also lets you select and monitor I/O or memory addresses being written or read to. This can assist programmers in debugging software and hardware problems.

QuickPost PS2 is a $195 POST code card for MicroChannel computers that indicates POST codes and power-supply voltages.

One final POST-code product from Ultra-X is the $79 Micro-P.O.S.T. This interesting device plugs into a parallel port and displays POST codes for any computer whose POST routine outputs results to the parallel printer port address, which includes virtually all IBM PS/2 models, IBM notebook computers and systems that utilize newer BIOS designs. A 10-segment LED indicator on the device displays the POST codes. Micro P.O.S.T. also doubles as a parallel/serial-port loopback plug. Included software assists you in monitoring POST routines, decoding the LED POST codes and testing parallel and serial ports.

• ***IRQ/DMA Detectors.*** Many PC problems are caused by IRQ and DMA conflicts (see the "Minding Your DMAs and IRQs" box). These conflicts usually occur after performing an upgrade, such as adding a multimedia kit to a system. IRQ/DMA detector cards can be helpful either before the upgrade to tell you the status of your own or an unknown system or after the upgrade if you run into conflicts that are difficult to resolve.

The $299 16-bit Discovery Card from AllMicro uses 18 logic probes to detect interrupts and DMA channels. Whenever an IRQ or DMA request is made, the card turns on the appropriate LED. The LED stays on until the system is reset or a RESET button on the card is pressed.

The $299 16-bit Examiner from Ultra-X also monitors IRQ lines and DMA channels and has 18 LEDs, red for interrupts and green for DMA channels. Additionally, it monitors the temperature of the system (a LED lights if the system unit becomes too hot) and the voltages in the system (a 10-segment LED indicator displays supply voltages that are out of line). There are also a RESET switch and a buzzer on the card.

• ***Power-Supply Test Cards.*** The power supply is often the source of problems in a personal computer. If it doesn't die altogether, it sometimes becomes erratic and can be the cause of intermittent failures, system lock-ups, loss of data, etc. Although most of the diagnostic cards already described can check power-supply voltages, some products are dedicated to this task. And although most POST-code cards are designed for temporary operation

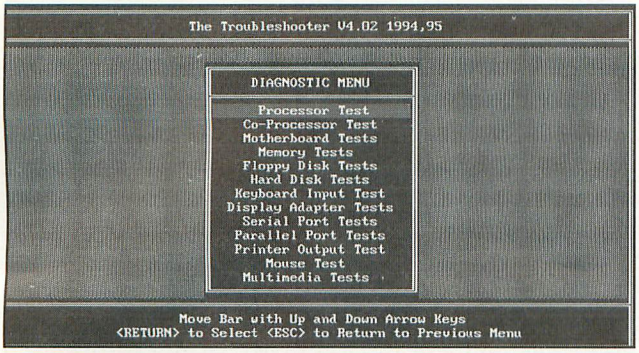


Fig. 1. Shown here are the 13 major tests of the Advanced Diagnostics menu from AllMicro's *The Troubleshooter.*

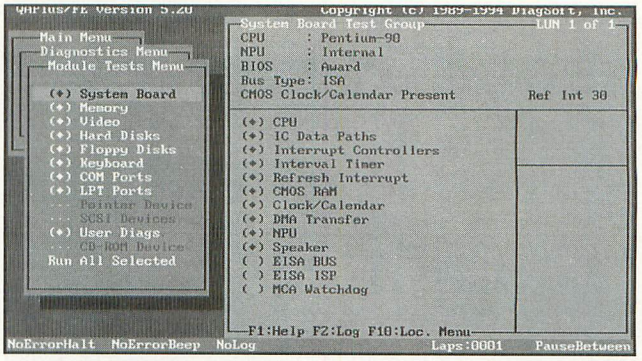


Fig. 2. Here are the 10 major module tests of the Diagnostic Menu from DiagSoft's *QAPlus/FE* Version 5.12.

in a PC (they should be removed after tests are performed), power-supply test cards are usually designed for permanent installation in a PC or file server to provide constant monitoring of the condition of the power supply.

AllMicro's $339 Alert Card monitors and records both power and temperature changes in a PC or file server. A LED lights and an audible alarm sounds whenever the system's power or temperature goes beyond a certain safe operating range. The card can be used in two different modes: monitor and diagnostic. In monitor mode, it's permanently installed in a PC or server. In diagnostic mode, the card can be used to troubleshoot a system and verify power-supply quality.

PC PowerCheck from Data Depot, which sells for $269, is an eight-bit card that can be used to test either PC or Amiga power supplies. The card contains a 12-pin power-supply connector that's identical to those used on PC motherboards. Thus, you can plug the card into an expansion slot on the PC's motherboard to monitor the power supply, or you can plug the power supply directly into the PC PowerCheck card and test the supply without the motherboard. Power resistors on the card simulate motherboard load conditions.

PC PowerCheck tests the four power-supply voltages for over/under-voltage, noise and transient conditions to within 3% of original IBM limit specifications. A LED lights for each error condition detected in each of the four voltages. The card also monitors the system's reset signal. Error detectors operate in continuous or trap mode. Trap keeps the LED on until you reset it. Green summary LEDs along the back edge of the card light to indicate that the corresponding detectors have found no errors.

• ***Add-In Board Testers.*** If you want to test an expansion card, such as a hard-disk controller, ICS Electronics makes four extender cards that can help you do so. The $595 EISA-EXT, $595 VL-EXT, $495 AT-EXT and $295 PC-EXT are designed for EISA bus, VL bus, 16-bit ISA bus and eight-bit ISA bus PCs, respectively. With the appropriate ICS extender card plugged into an expansion slot on a PC's motherboard, you can plug an expansion card into the top of the extender card for testing purposes.

One of the benefits of using the extender card is that it lets you plug cards into the computer for testing while the computer is powered up. The extender card can be used manually or automatically, with commands issued by a card test program.

Features of the extender card include monitoring power to the card under test, programmed turn-on/turn-off of power and signals and status reporting.

• ***Video-Monitor Testers.*** When the video system of a PC breaks down, several culprits can be involved. Two obvious ones are the video adapter card and the computer's video monitor. However, motherboard problems, such as dirty contacts in an expansion slot, and defective expansion cards can also cause video to fail to appear. Monitor testers help you isolate the

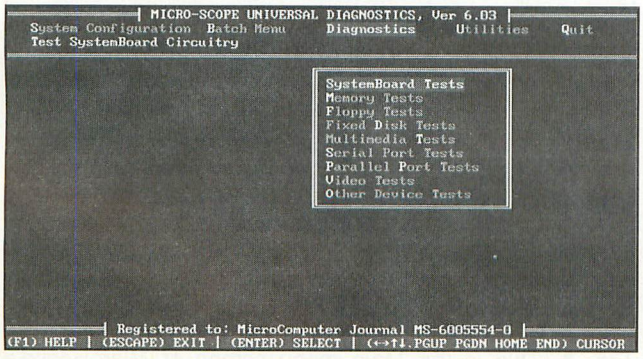


Fig. 3. These are the 12 major tests on the Diagnostics Menu from Micro 2000's *Micro-Scope* Version 6.0

Fig. 4. This is the Diagnostics Menu from Landmark's *WINProbe* Version 3.0, which includes 14 separate tests.

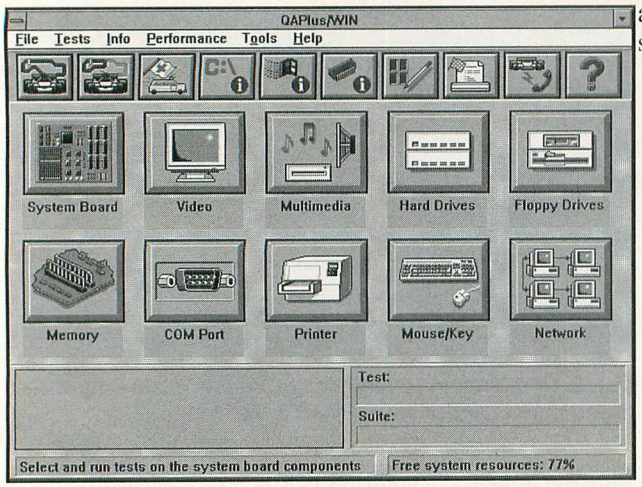


Fig. 5. Clicking on any one of the 10 test buttons on the main screen from DiagSoft's Version 6.0 of *QAPlus/WIN* brings you to the set of tests for that module.

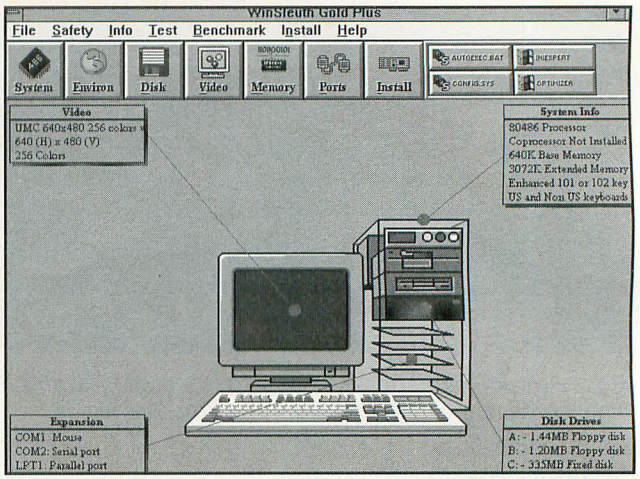


Fig. 6. Shown here is the Main Button Bar from E Ware's *WinSleuth Gold Plus* Version 2.0.

problem quickly. These instruments tell you if the monitor is working or not. Testers also are helpful for tuning up a monitor, that is, restoring parameters to their optimum settings. Another use is for checking monitors that have been on the shelf—to quickly test if they're operational—without having to connect them to a PC.

The Checker Series of computer monitor testers from Computer Monitor Maintenance are hand-held battery-operated units that quickly check if a computer monitor is working. The $295 Checker 12 is a color monitor pattern generator that can test PC monitors from CGA up to 1,024 X 768 SVGA interlaced or non-interlaced and 640 X 480 Mac II monitors. The unit's microprocessor is programmed to closely match the recommended VESA standard for each operating mode. A color-bar/eight-step-gray-scale pattern permits quick evaluation and setting of color balance and tracking. The $99.95 Checker Jr. is about half the size of the Checker 12, and works only in the 640 X 480 VGA mode.

Sencore's $2,995 CM125 "Pix Pak" Computer Monitor Signal Generator is a high-end instrument that can test video monitors with up to 2,048 X 2,048 resolution. Chief among its features are a fully programmable scan frequency and pixel-resolution RGB video generator. The CM125 also boasts a complete set of video patterns to help identify monitor defects. With 100 storage locations (43 preprogrammed), you can quickly store and recall common monitor formats that you test.

Software

Even though you get diagnostic soft ware for free when you purchase Microsoft *Windows* (Microsoft Diagnostics, or MSD), this hasn't stopped a host of companies from developing and updating competing products. Diagnostic software generally falls into one of three categories: general system diagnostics, specific subsystem diagnostics and data recovery. Keep in mind that to use diagnostic software, most of your system must be up and running.

• ***General Diagnostic Software.*** You can use this type of software to check out the various parts of your system—for example, motherboard, CPU, memory, ports, floppy- and hard-disk drives, etc. You'll find that some products are operating-system-independent, while others require DOS and still others operate under *Windows*. For the most part, diagnostic software works as advertised. However, one of the big knocks against this type of software is that it can't

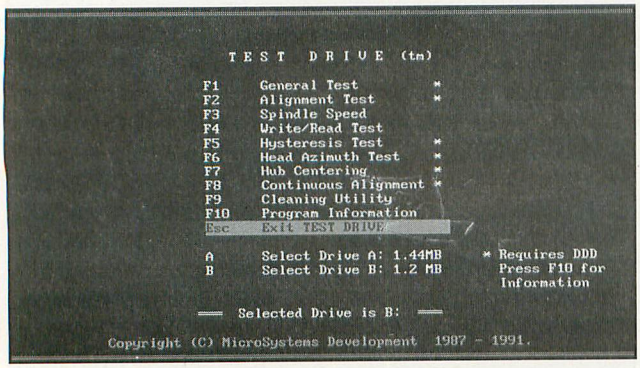


Fig. 7. These are the major test procedures you can perform with MicroSystems Development's *Test Drive*.

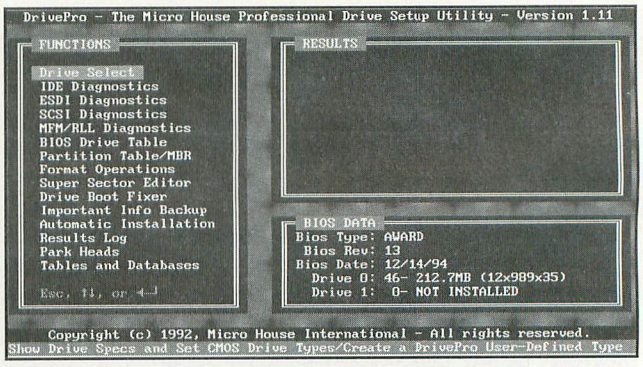


Fig. 8. This is the Main menu screen of MicroHouse's *DrivePro*, which offers plug-and-play installation of IDE drives and a complete list of hard drives from 1984 to the present.

perform an essential task: reporting complete interrupt use and conflicts.

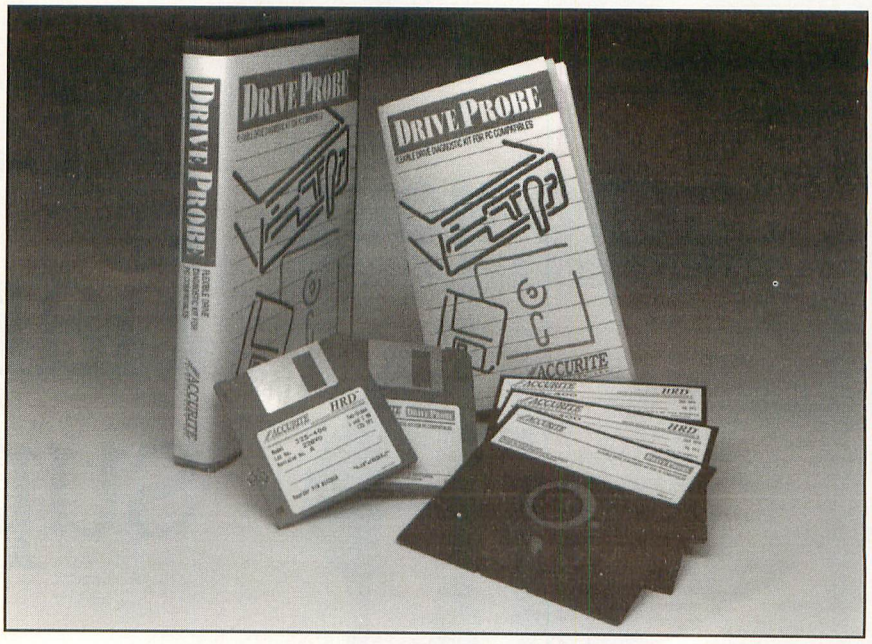
Ultra-X's $99 *Quicktech Lite*, Windsor Technologies' $195 *PC-Technician PC3030* Version 3.5, AllMicro's $299 *The Troubleshooter*, DiagSoft's $349.95 *QAPlus/FE* 5.12 and Micro 2000's $499 *Micro-Scope* Version 6.0 are all operating-system-independent packages. DiagSoft's $99.95 *QAPlus* Version 4.8 and Ultra-X's $249 *Quicktech Pro* run under DOS. *Quicktech Lite* is a new product that works from a single disk and performs complete system diagnostics, including tests on cache and video memory.

New features of *PC-Technician* PC3030 Version 3.5 include support for Pentium-based PC systems, certain Adaptec SCSI host adapters and drives attached to them and testing COM4 and up to 64 user-defined serial port addresses. It also includes improved memory tests, with support for testing up to 1G of extended memory.

Figure 1 details the 13 major tests of the Advanced Diagnostics menu of *The Troubleshooter*. The latest version of *The Troubleshooter* includes multimedia and CD-ROM testing, cache memory and video RAM testing (up to 4M) and an I/O-port map. The package includes loopback plugs, a CD-ROM disk test disk and both 3½" and 5¼" floppies.

Shown in Fig. 2 are the 10 major module tests of the Diagnostic Menu of *QAPlus/FE* Version 5.12. The latest version now includes upgraded component tests. For example, the SCSI test now supports multiple drives (LUNs) and lets you choose starting and ending blocks. Enhanced memory and video tests have been added to support specific cache-controller and video-accelerator chips. An enhanced memory map now identifies QEMM high-RAM areas and DOS programs loaded into these areas. An enhanced IRQ report now identifies IRQs generated by the Microsoft Sound Card and other devices. The package includes loopback plugs, 3½" and 5¼" floppy disks and a *Co-Session* disk for remote diagnostics.

The 12 major tests on the Diagnostics Menu of *Micro-Scope* Version 6.0 are illustrated in Fig. 3. The latest version now includes full testing of cache memory and the cache-controller subsystem. Memory testing enhancements let you accurately test IRQs, DMAs, system memory and up to 4M of video memory. This version also reads and displays actual parameters for any drive type, without the need for operator intervention, whether or not the drive is set in the system CMOS. The package includes loopback plugs and 3½" and 5¼" floppy disks.



Accurite's Drive Probe kit.

New features of *Quicktech Pro* include a FAT editor for all physical and logical drives, a SCSI identifier for SCSI devices using ASPI standards and a memory scanner that scans base memory to detect programs, BIOS, TSRs and device drivers. The new version also includes a CD-ROM for multimedia testing.

General diagnostic software for Microsoft *Windows* includes the $49 *WINProbe* 3.0 from Landmark, the $49.95 *WINCheckIt* from TouchStone Software, $49.95 *First Aid* from CyberMedia, $79.95 Hurricane from *Helix*, $99.95 *QAPlus/Win* Version 6.0 from DiagSoft and the $99.95 *WinSleuth Gold Plus* Version 2.0 from E Ware. All of these programs give specific *Windows* information, as well as general system information.

In Fig. 4 is shown the Diagnostics Menu of *WINProbe* Version 3.0, which includes 14 separate tests. Among its other features, *WINProbe* Version 3.0 includes PCMCIA tests for driver and slot and more than 300 tune-up suggestions for *Windows* and popular *Windows* programs.

Besides hardware tests, *WINCheckIt* includes a set of utilities that help in locating set-up problems, uninstalling unwanted *Windows* applications, benchmarking a system, undoing system changes and deleting unnecessary files.

First Aid is different from most other diagnostic programs. It's a knowledge-based program that sits in the background, without interrupting normal operations. When a *Windows* error appears, such as a missing DLL, incorrect parameter or bad path, a pop-up window appears and offers to repair the problem on the spot. The program also uses its knowledge base to analyze and correct problems that occur with popular *Windows* programs, and it fixes problems with multimedia device drivers.

Hurricane is a new product that combines reporting and analysis with speed-enhancement utilities. Its three major components are Discover for Windows, WinGauge and the Hurricane utilities. Discover for Windows reports information on every aspect of *Windows* and DOS operations. WinGauge provides a graphical representation of all important *Windows* activities. The Hurricane utilities consist of a set of tools that are designed to solve the resource, memory, speed and reliability problems of *Windows*.

Figure 5 illustrates the 10 test buttons on the main screen of Version 6.0 of *QAPlus/WIN*. Clicking on any

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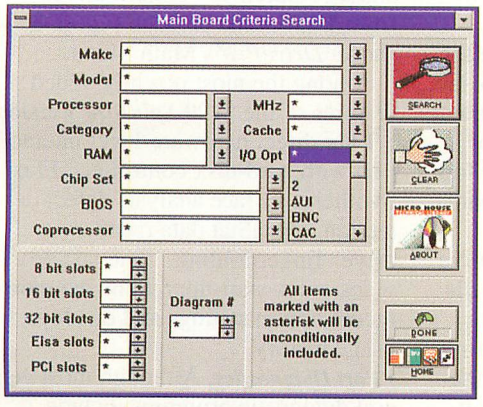

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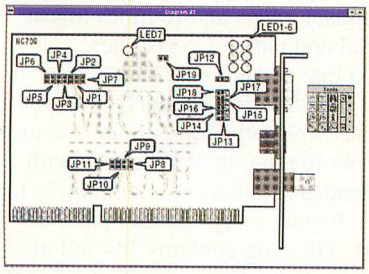

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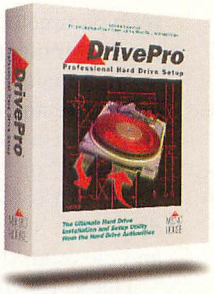

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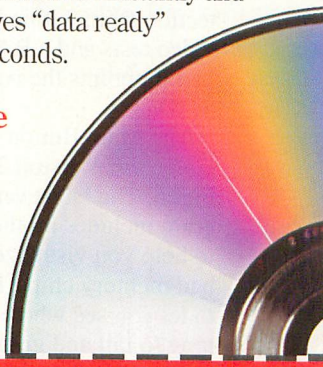

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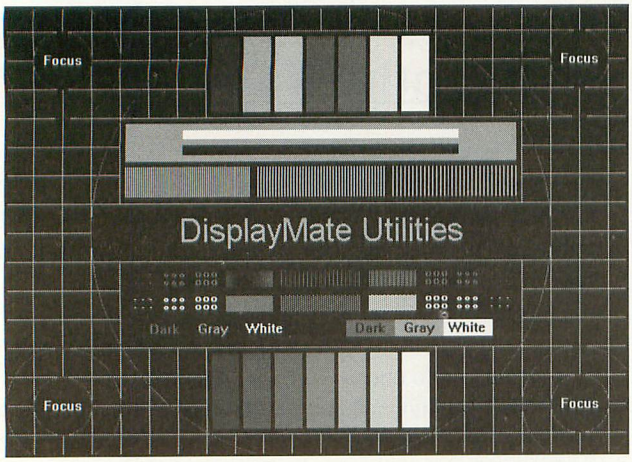

Fig. 9. A typical screen from Sonera Products' *Display Mate*, an expert system that shows how to precisely set all of the parameters and controls and make adjustments on video monitors and video cards so that they work together as an optimized system.

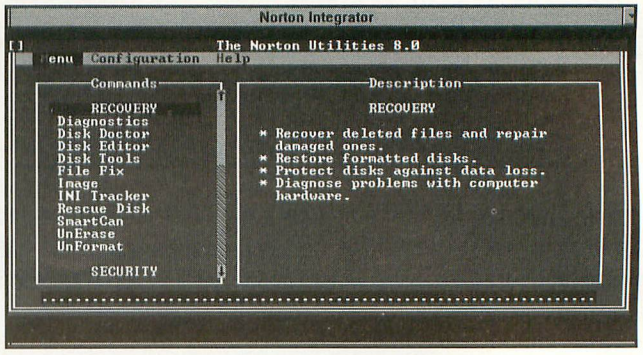

Fig. 10. This is the Data Recovery screen from Symantec's *Norton Utilities*.

button brings you to the set of tests for that module. The latest version of the program now includes automatic on-line access to DiagSoft technical support for troubleshooting fundamental PC problems (the first consultation is free). It also includes IRQ detection from within *Windows*, new video tests and a RAM-chip locator that pinpoints the positions of faulty SIMMs.

The Main Button Bar of *WinSleuth Gold Plus* Version 2.0 is shown in Fig. 6. The latest version of this program includes motherboard graphics to help you visualize the location of bad memory chips, hard-disk graphics to let you see where a platter is beginning to fail and graphic displays of statistical information and performance benchmarks. This version also includes a conflict finder for discovering conflicts with multimedia and other expansion devices.

• ***Floppy-Disk Drive Diagnostics.*** With floppy-disk drives costing considerably less than $100, you wouldn't think there would be much call for diagnostic software for them, especially since the software often costs more than the drive itself. However, if your job requires you to keep lots of computers in tip-top shape, it's nice to have a professional tool that tells you definitively whether or not a drive is working properly.

Several products can assist in keeping floppy drives in top form. Typically, these products offer about 10 different diagnostic procedures to test such parameters as rotation speed, head alignment and others.

Trackmate's $29.95 4-in-1 disk drive care and diagnostics kit uses the HyperBrush cleaning technology to clean 3½" or 5¼" disks. For both sizes, cost is $29.95. 4-in-1 includes diagnostic software, cleaning disks and cleaning fluid.

The $115 MicroSystems Development Test Drive includes a program disk and Dysan precision diagnostic disks for both 3½" and 5¼" floppy drives. The major test procedures you can perform with this product are illustrated in Fig. 7.

Data Depot's $129 FloppyTune kit includes head-cleaning and diagnostic diskettes and a Spiral Track alignment disk. It comes with either a 3½" or 5¼" disk. For $199, you can get FloppyTune Deluxe, which includes both diskette sizes.

Accurite Technologies' $199 Drive Probe uses HRD (high-resolution diagnostic) diskettes for its tests. Not only can it help diagnose and repair standard PC drives, it can handle the 600-rpm floppy drives found in software-duplication equipment.

• ***Hard-Disk Drive Diagnostics.*** The hard disk is arguably the most-important subsystem of a personal computer. If you've ever experienced a hard-disk crash, you know how devastating an occurrence it can be. Though there's no way to guard against a real mechanical breakdown of a hard-disk drive (other than by backing up your drive regularly to protect your data), several products are available to help you avoid other kinds of hard-drive problems like surface defects. (Microsoft also competes in this arena with its SCANDISK utility, which is included with DOS 6.x.) Besides diagnostics, these programs usually offer a whole slew of hard-drive related utilities, such as low-level formatters, benchmark tests, etc.

Besides the typical hard-drive diagnostic routines and utilities, MicroHouse's $99 *DrivePro* offers plug-and-play installation of IDE drives and a complete list of hard drives from 1984 to the present. Figure 8 shows *DrivePro*'s Main Menu.

Among the most recently added features of the $129 *SpinRite* Version 3.1 are direct hardware-level interaction with hard-disk controllers, Flux Synthesis surface analysis defect detection, DynaStat data recovery and drive "fingerprinting." The last provides quick start-up, retains the most-recent option settings and displays usage history.

• ***Port Diagnostics.*** Although most general diagnostic programs include loopback plugs and routines to test serial and parallel ports, there's at least one product that's dedicated to this task. MicroSystems Development' $59 Port Test uses an odd-looking wrap plug, in conjunction with diagnostic routines, to completely test and diagnose any serial or parallel port. The plug contains 25- and nine-pin serial connectors, a 25-pin parallel connector and LED indicators. A di-

(Continued on page 109)

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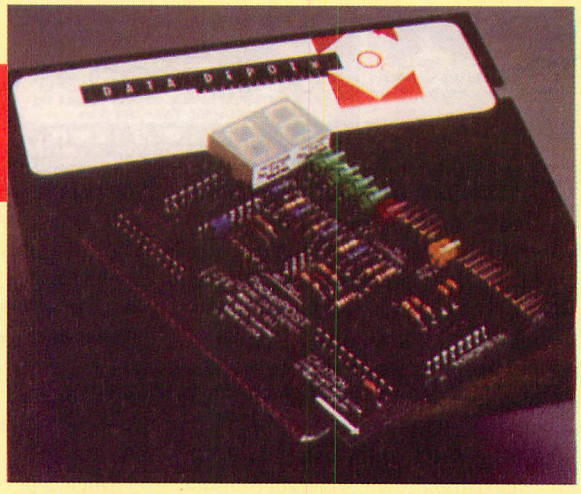

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By Jan Axelson

Using Computers as Test Instruments

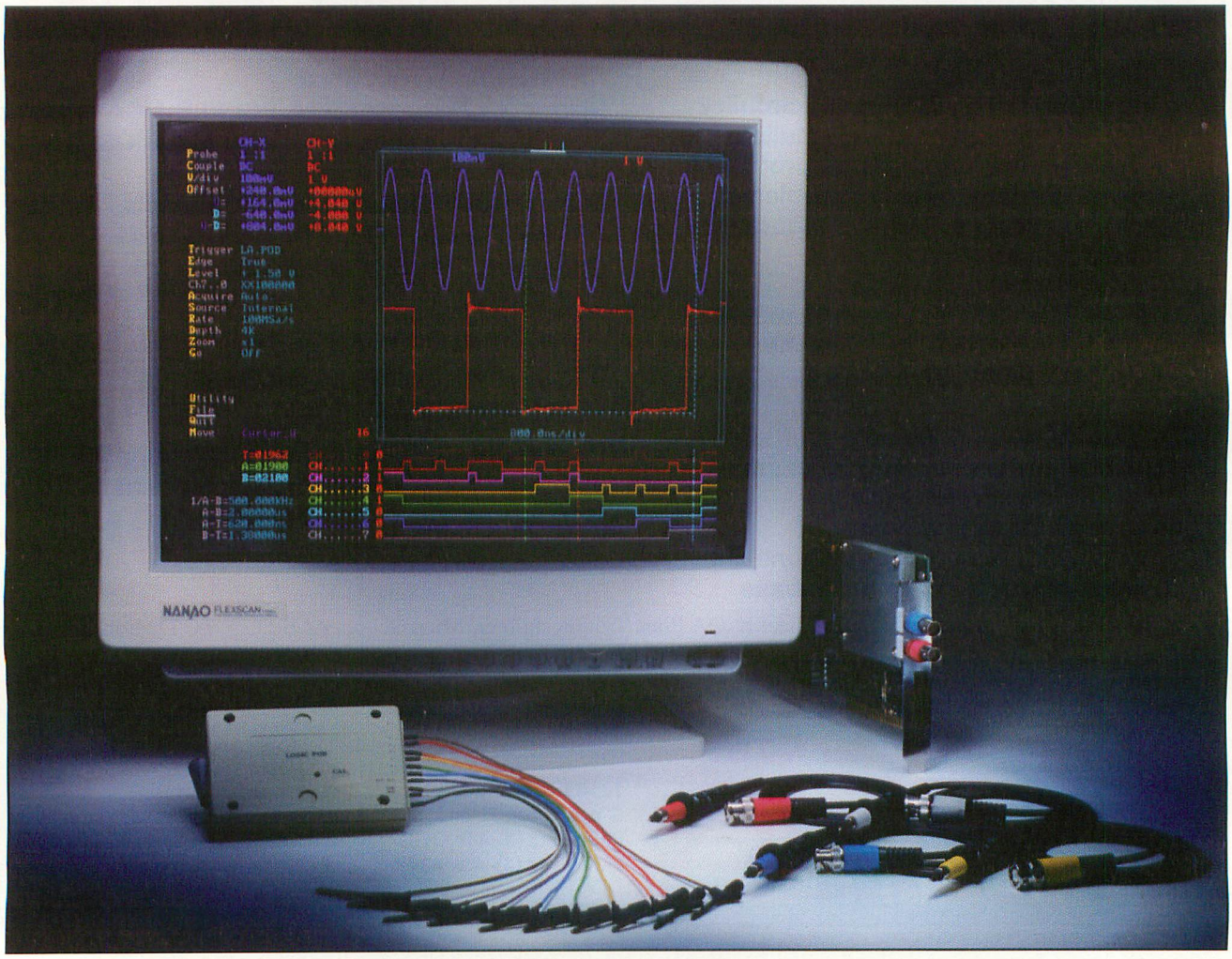
PC-based oscilloscopes and logic analyzers

Among the many things you can do with a personal computer is to use it as a tool for testing and troubleshooting electronic circuits. Two of the most-powerful and flexible tools for this purpose are the oscilloscope and the logic analyzer. An oscilloscope, or scope for short, can display both analog and digital signals, while a logic analyzer displays only digital waveforms. With some added hardware and software, a personal computer can perform the functions of either of these instruments.

Conventional scopes and logic analyzers contain circuits that detect, amplify or attenuate and filter the inputs. They also have keys or knobs for user control and a display to graphically show resulting waveforms. Modern scopes and logic analyzers usually contain a microprocessor for more-sophisticated control over gathering, processing, storing and displaying input data.

Since a personal computer already has a keyboard, display, memory and processing power, it makes sense to use it as the basis for a test instrument. All you need to add are circuits to translate the inputs into a form the computer can read and the software to control and display the inputs. In fact, PC-based scopes and logic analyzers are available in a range of abilities and prices.

In this article, I explore the possibilities in PC-based scopes and logic analyzers. I cover such things as the uses for these instruments, what's available, how they compare to conventional instruments and how to buy



a scope or logic analyzer that meets your requirements and budget.

PC-Based Vs. Conventional

I'll use the term "conventional instrument" to refer to a traditional stand-alone instrument that isn't based on a personal computer. Both PC-based and conventional instruments have their places.

PC-based instruments have several advantages over traditional conventional instruments. As a general rule, an instrument built around a personal computer costs less than its equivalent in conventional form, assuming you already have the computer into which to plug the instrument. Because the existing computer has the display, keyboard, storage and some or all of the instrument's intelligence, you don't have to pay extra for these. The added circuits for the scope's or logic analyzer's inputs may be on an expansion card or module that connects to your computer by cable to a serial or parallel port.

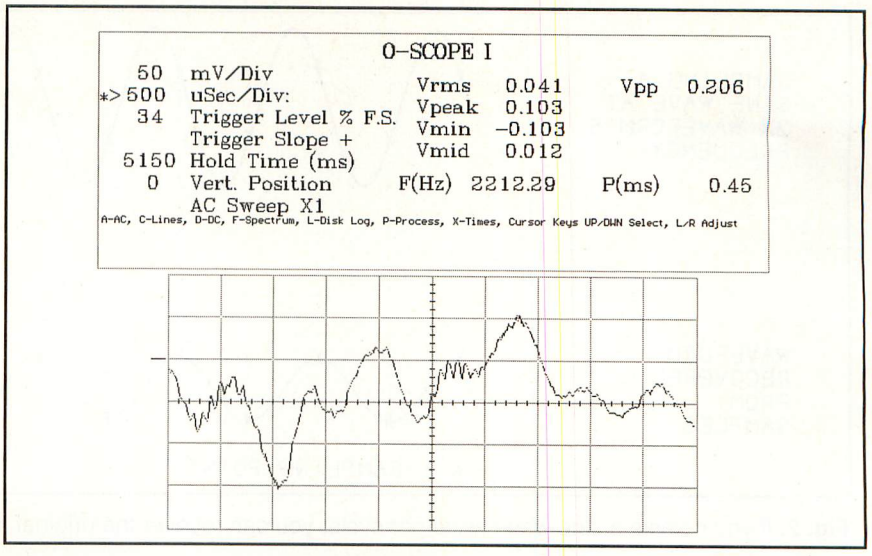


Fig. 1. Allison Technology's Oscope-I offers an inexpensive way to use a personal computer as an oscilloscope. The display shows an audio waveform from a radio broadcast.

Many PC-based instruments make it easy to use the data gathered with other software. You can import data to a spreadsheet, a math-analysis program or other application. Some instruments come with programming libraries, device drivers, *Windows* DLLs (dynamic link libraries) or *Visual Basic* custom controls that let you control the instrument from within a program you write. A conventional instrument might allow you to trans-

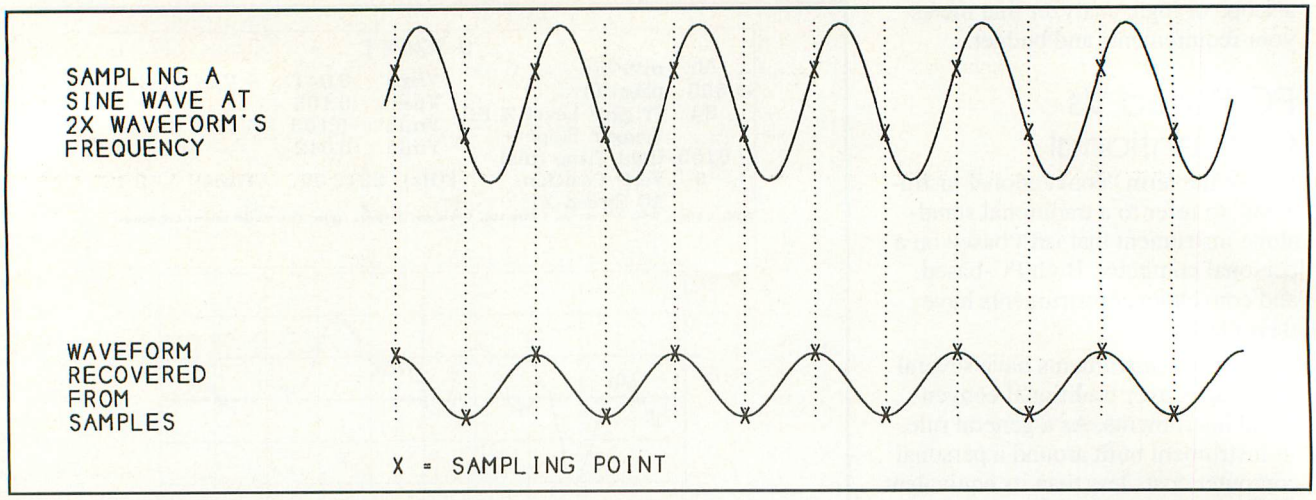


Fig. 2. If you sample a sine wave twice per cycle, you can recover the original frequency but not its amplitude or phase.

fer data to a computer via a floppy disk or cable-connected interface, but with a PC-based instrument, the interface is built-in.

A computer display is often of much better quality than the display on a conventional instrument. Many scopes have a small 3" X 4", single-color (monochrome) display, while computers often have 9" X 12" color SVGA displays. Even when the monitor shows controls, menus and status information and the input waveforms, there's still a large area left over for displaying the inputs on a computer's video monitor. Use of color also helps a lot in making it easy to follow individual signals and other information.

A computer's keyboard frees you from the limitations of front-panel buttons and knobs. For example, on a conventional scope, you set the trigger voltage by adjusting a knob while viewing the results on the display. On

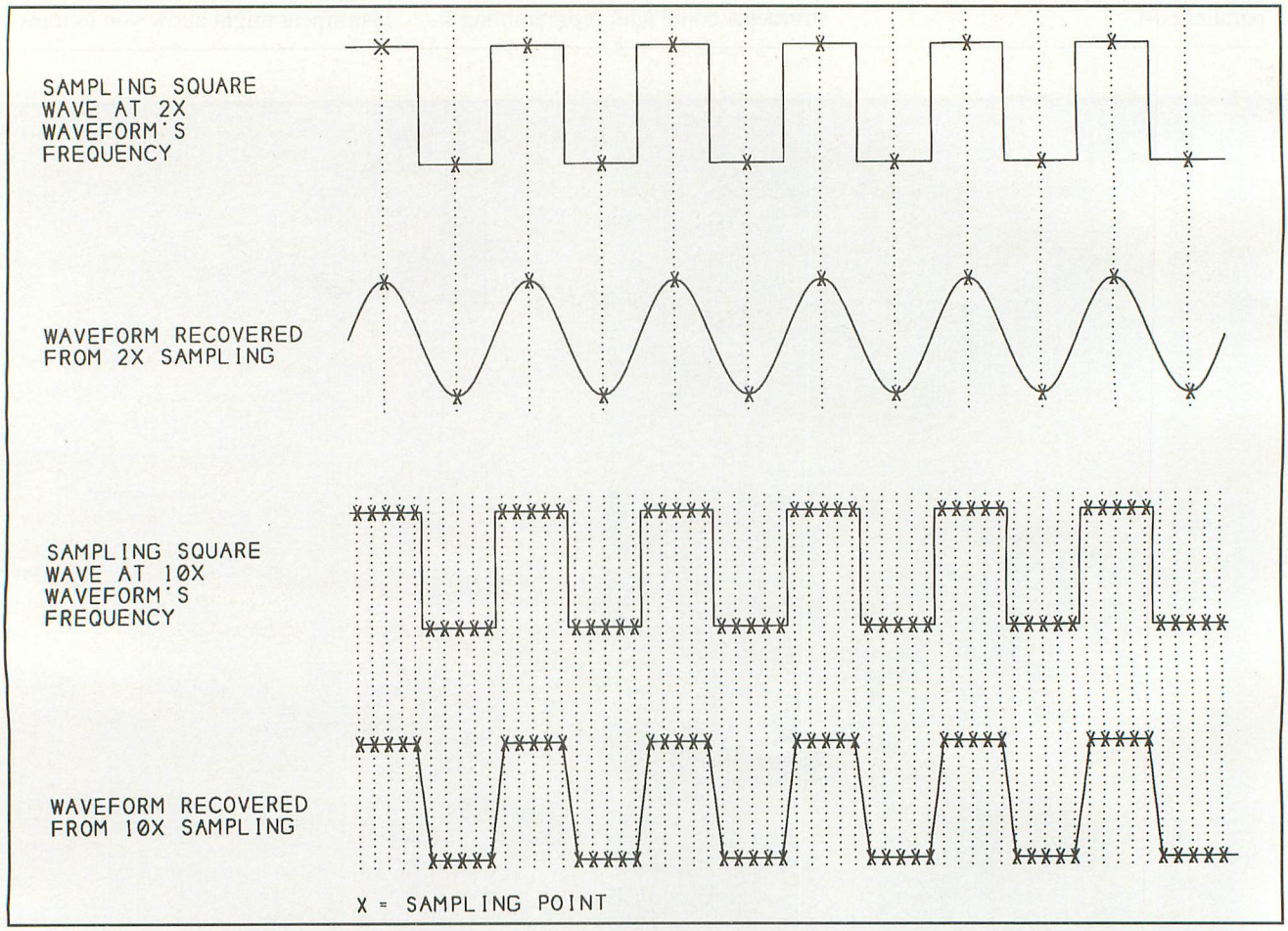


Fig. 3. To recover the approximate shape of a square wave, you must sample at five to ten times the square wave's frequency.

many PC-based scopes, you can type in a trigger voltage directly, for a precise setting without tedious adjusting. It's also easy to permit a wide range of settings from a keyboard because you're not limited by the number of poles on a knob-adjusted rotary switch.

Of course, PC-based instruments do have limitations. For example, most conventional instruments are housed inside portable boxes you can easily move to wherever you need them. Laptop and notebook computers are portable enough, but they're useless if the instrument needs an expansion slot. Moving a desktop computer means unplugging and relocating the system unit, keyboard and display and then setting it all up in the new location. True, you can dedicate a computer to serve exclusively as a test instrument, but this defeats the cost savings of using an existing computer.

Using a computer as a test instrument also means that it may not be available when you need it for other purposes. *Windows* and OS/2 permit multitasking, but you may want to devote all of the computer's resources to testing and measuring, or you might have to move the computer to a location that isn't convenient for doing other work.

If you're accustomed to twisting knobs and pressing buttons on conventional instruments, the keyboard interface may take some to become accustomed to using it. To make the transition easier, some products emulate the traditional controls on-screen. Plugging scope probes into a computer's rear panel can also be inconvenient and may require longer probes.

Although a good selection of PC-based instruments exists, conventional instruments still dominate the high-end marketplace, especially in models that have high frequency response.

Oscilloscope Basics

If you had to select just one instrument for testing circuits, it would almost certainly have to be an oscilloscope. A scope can help you view, measure and analyze signals in all kinds of circuits, including oscillators, counters, converters, amplifiers, regulators, line voltages, computer buses, serial data links and, in fact, just about any circuit or waveform that comes to mind.

In displaying analog and digital signals, a scope can also double as a voltmeter, frequency counter, logic analyzer and more.

Features and abilities vary hugely depending on the scope's model and vintage, but all these instruments display input voltages in relation to time. Figure 1 is an example of a typical display.

Most scopes can display two or more channels simultaneously. Most also permit you to trigger, or start, the display when the rising or falling edge of a signal reaches a voltage you select. For example, you can trigger on the falling edge of a clock, or when a sensor's output rises to a selected voltage or on the zero-crossing of a sine wave.

To use a scope to view a signal, you clip your probe to the input you want to view, set the timebase and vertical scale to appropriate values and the trigger voltage so that the sweep or

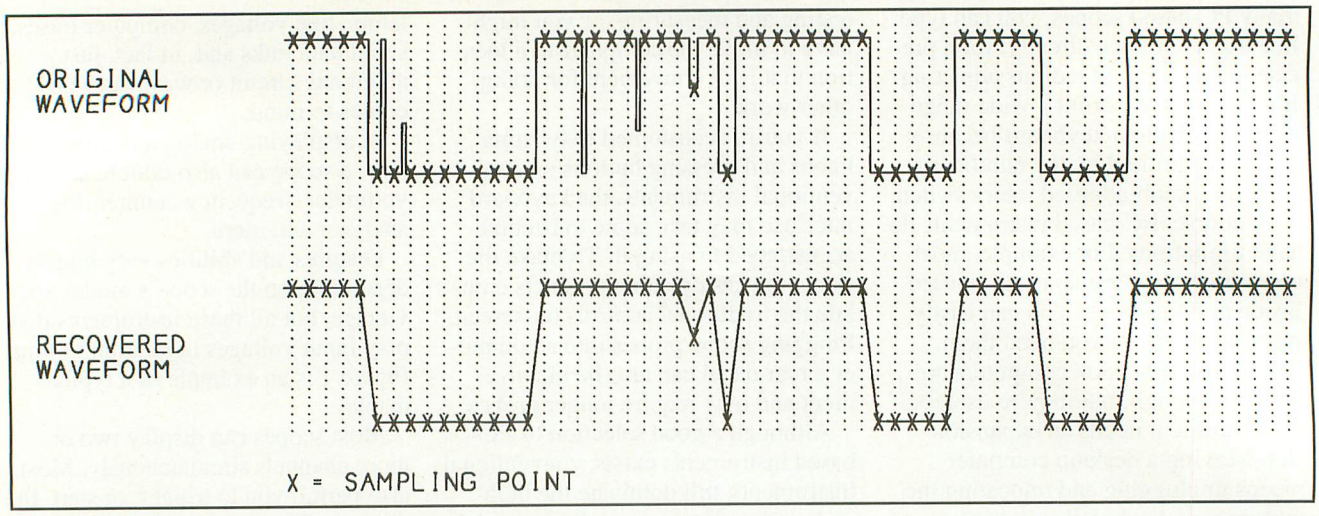


Fig. 4. With a sampling rate that takes five or more samples in the shortest pulses, you can recover a fairly accurate picture of a digital waveform, though the samples may miss or distort brief noise spikes.

waveform display begins at the desired point on the waveform of interest.

The timebase setting varies the speed of the beam as it sweeps across the display from left to right. The volts-per-division (V/div.) setting determines the vertical scale of the sweep, or how far the beam moves vertically for a particular input voltage.

In many ways, scopes are similar to a category of instruments called data-acquisition systems. Although I concentrate in this article on scopes and logic analyzers, because of their similarities, I'll say a few words about data-acquisition systems.

Both scopes and data-acquisition systems measure voltages over a selected period of time. In general, though, data-acquisition systems are designed for long-term monitoring or for performing a single task over a period of time, while oscilloscopes are intended as general-purpose test instruments for measuring different things every day or even minute-to-minute. For example, you might set up a data-acquisition system to monitor ozone levels at a site, while you'd use a scope for tasks relating to setting up or maintaining the site, such as verifying the output voltage of a sensor or troubleshooting a computer interface.

In the past, a data-acquisition system typically consisted of sensing circuits that were connected to a chart recorder that, in turn, plotted measurements over time. These days, a computer provides a much more powerful and flexible way to store and display gathered data.

Reflecting their purpose, data-acquisition systems often concentrate on features like huge buffers, expanded timebases that let you sample data over a long period and ease of converting data to different formats, while oscilloscopes focus more on giving a realtime display for a wide variety of input voltages, frequencies and trigger sources. For both types of instruments, understanding specifications like sampling rate, bandwidth and resolution is important in selecting and using these instruments.

Analog Vs. Digital

The original oscilloscopes were analog instruments. They remain popular to this day, in part because they tend to be less expensive than digital scopes that offer the same frequency response. From the user's perspective, the greatest difference between analog and digital scopes is that the former display information only in realtime (as it occurs), while digital scopes store waveforms you can display and study at your leisure. Another term for a digital scope is digital storage oscilloscope, or DSO.

The display in most scopes is the common cathode-ray tube, or CRT. In an analog scope, the input voltage more or less directly controls a pair of deflection plates that determines the vertical position of the beam on the display's screen. A timebase circuit controls a second pair of plates that determines the sweep rate, or how fast the beam moves across the display's screen. When a trigger occurs, an electron beam traces the input waveform on the screen, and the screen's phosphor coating causes the display to glow where the beam hits it.

Analog scopes work well for viewing repetitive signals. For example, to view an oscillator's output, you can trigger on a rising or falling edge of the signal. After each sweep, the scope re-triggers on the next edge. The result is a continuous display of the signal.

If a signal occurs just once, or if it repeats so slowly that each trace fades long before the next one begins, you must be quick to catch the signal on the display.

The glow of the phosphor on the screen has some persistence due to its gradual decay. However, once a waveform fades, it's gone. On an analog scope, no long-term storage exists, except for a very few expensive units that employ CRTs that have long-persistence phosphor, screen-refresh circuits or a scope-mounted camera to preserve a waveform.

A digital scope is a much better solution for storing waveforms. Like analog models, most digital scopes have a CRT display, but the two are very different inside. Computer control and digital storage give you many more options for saving and processing data.

Instead of the input voltages directly controlling the display, each input of a digital scope goes to an analog-to-digital converter (ADC). The ADC samples the input at a defined rate and converts each sample to digital form.

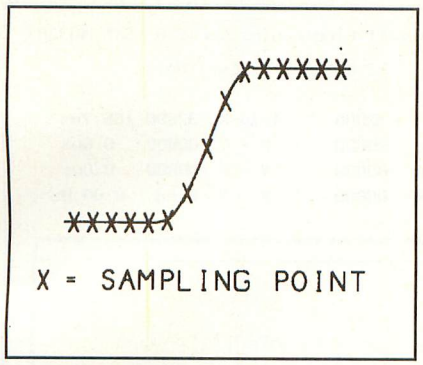


Fig. 5. If you want to observe the exact shape of a digital signal, such as the rise time of a digital pulse, you need a very fast sampling rate.

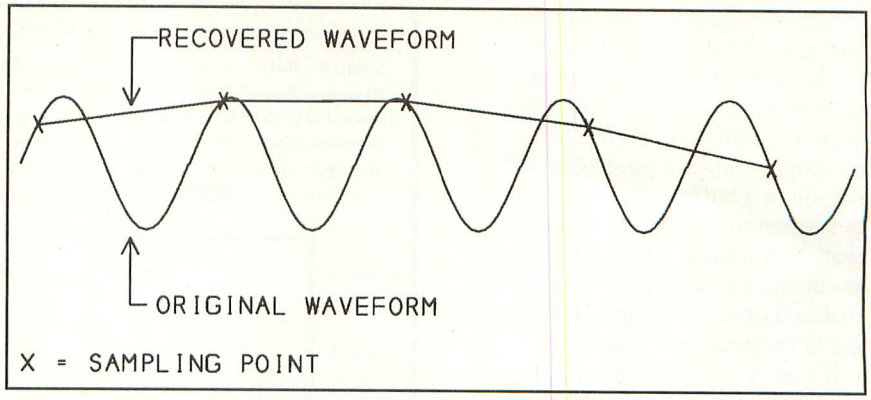


Fig. 6. Here's one example of aliasing, where a too-slow sampling rate gives a false result. Sampling at slightly less than the original frequency causes the recovered waveform to be a much lower frequency than the original.

A computer stores the samples in memory, where the scope uses the stored information to display all or part of the signal.

The number of bits in the scope's ADC determines measurement resolution, or how precisely the scope measures the input. An eight-bit ADC translates an analog input into a number between 0 and 255 (0FFh). Most scopes use eight-bit ADCs, in part because the display also has limited resolution. This being the case, more bits would make little difference in the displayed waveform.

You can change the resolution of an ADC by changing its input range, which is the voltage that results in a full-scale output. In most scopes, changing the V/div. setting also changes the ADC's range during signal capture. For example, on Emulation Technologies' ET-DSO scope, at a setting of 5 mV/div., the display shows a 40-mV span, with a resolution of 167 μV/bit. With a setting of 5 V/div., the display shows a much wider 40-volt span, but resolution drops to 167 mV/div. For greatest resolution, you'd set V/div. to the smallest value that permits you to see the entire waveform in which you're interested. Once an input is captured and stored, you can change the V/div. setting to expand or shrink the displayed waveform, though this won't change its resolution.

Digital scopes (and logic analyzers) are especially handy in several specific situations. Typical examples of such situations include: when the signal you want to view doesn't repeat, when you can't predict at which point the signal will occur, when you need to see what occurred before the trigger and when you want to capture a signal over a period of time and then examine it section-by-section.

When a signal doesn't repeat, or if it repeats at a very slow rate, digital storage enables you to save the waveform and examine it whenever you wish. You can trigger on a waveform and display it either until the next trigger or indefinitely if you use a "single-shot" trigger. This gives you time to examine the waveform without having to be concerned about it disappearing from the screen.

As an example of the foregoing, if you want to view an infrared receiver's response to signals from a remote-control device, you can trigger on the receiver's output, press the remote-control button, capture the signal with the scope and view it on-screen. With an analog scope, you must be quick to see the waveform before it fades.

Storage is also handy when you can't predict when a signal will occur. For example, if you're looking for a noise glitch on an otherwise quiet line or if you're waiting for a transmission from a remote host and you have no way of knowing when the signal will occur. With an analog scope, the only choice is to wait and watch. With a digital scope, you can set the trigger voltage and go on to other things.

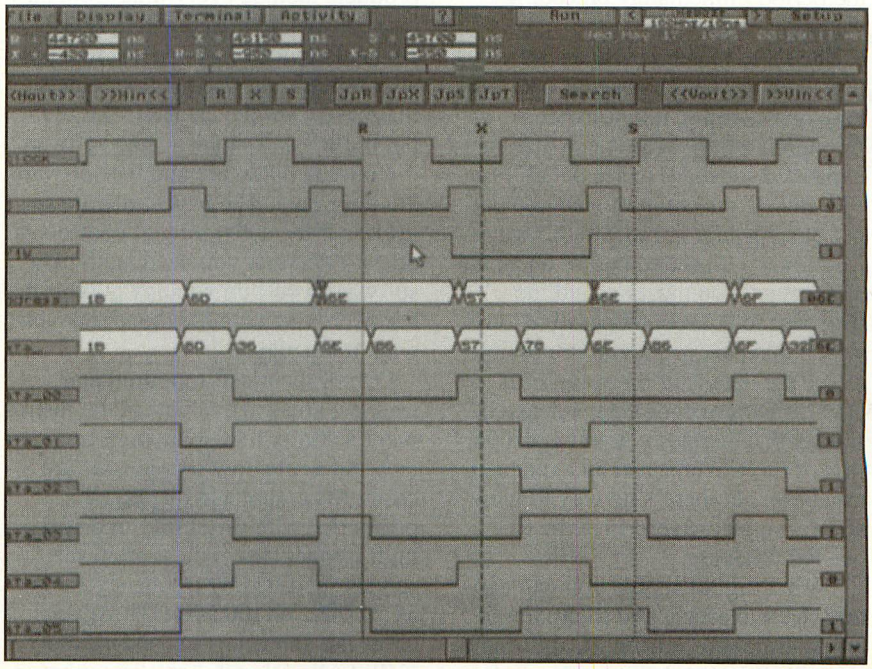


Fig. 7. This logic-analyzer display shows data, address and control signals on a 68HC11 microcontroller (Borge Instruments' BI 32100).

When the trigger occurs, the scope will save the waveform for you.

The ability to view signals in the time immediately before the trigger occurs is extremely useful. Most digital scopes can save pre-trigger information in a buffer. Viewing pre-trigger waveforms is handy when you want to track down the cause of an event and when a signal's shape makes it otherwise impossible to trigger at the point you want.

If you're accustomed to analog scopes, being able to see what occurred before the trigger can seem almost magical. The digital scope accomplishes this by continuously sampling an input and saving each sample in a buffer. When the buffer fills, the scope overwrites the earliest data, but it retains a history equal to the depth of the buffer. When the trigger does occur, the scope stops sampling so that you can display the stored data.

With most scopes that have this ability, you can select how much of the buffer to dedicate to samples before and after the trigger. For example, you might have an error signal—such as a watchdog time-out, reset or parity error—that occurs sporadically and for no apparent reason. To trace the cause, you can trigger on the error signal while monitoring another point on a second input channel. When the error occurs, you can look for clues to the cause by examining the input in the period immediately preceding the error.

The input buffer is also useful when you want to capture a signal over time and then examine it by scrolling through it a little at a time, using an expanded timebase to see detail. For example, if you want to view the output or a speaker or other audio waveform over a 2-second period on an analog scope, you must expand the timebase to 0.2 second per division, which makes it just about impossible to see the details of the waveform. Some analog scopes have a delayed trigger that enables you to view a portion of the waveform at an expanded timebase, but there's no way to view all of a single waveform at the expanded timebase.

With a digital scope, you can capture the waveform and then view it at any timebase setting. (Capturing a waveform over a longer period of time may result in fewer samples per second, however, depending on buffer size.)

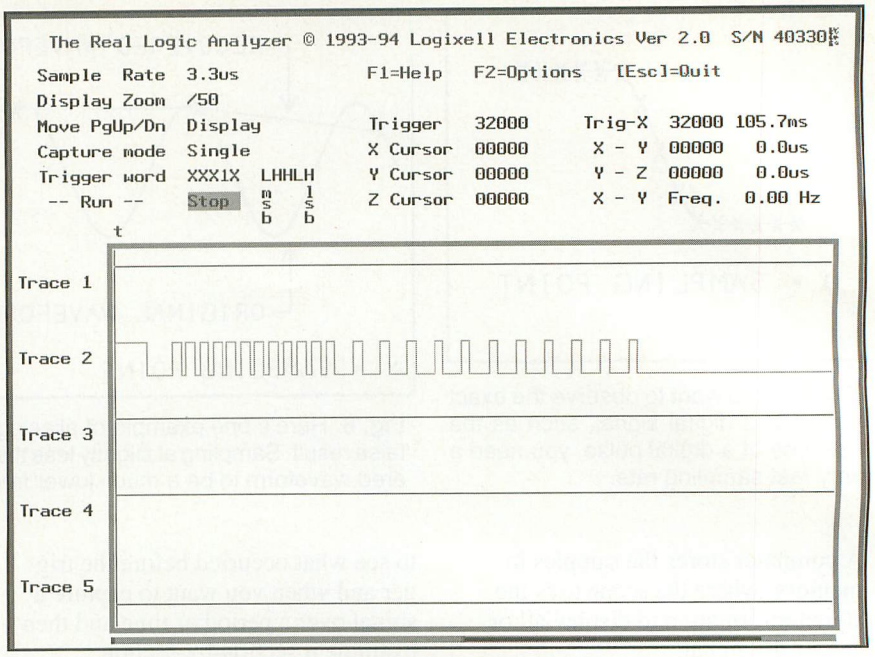


Fig. 8. This display from Logixell's Real Logic Analyzer shows how you can use a logic analyzer or scope to examine the output from an infrared remote-control device. The signal was captured by aiming a device at a GP1U52X infrared receiver module (available from Radio Shack) and connecting the receiver's output to the logic analyzer's input.

PC-Based Scopes

A PC-based scope uses a personal computer's display, keyboard, memory and computing power to process, store and display its inputs. Available products include everything from an inexpensive, low-frequency, single-channel device that connects to a parallel port to high-frequency models that have multiple channels, large input buffers and sophisticated software.

Both the hardware and the software are important. The best hardware is useless if the software that controls it doesn't do what you need, and great software won't do you any good if the hardware can't handle the inputs you want to display.

One of the most-important and trickiest areas to evaluate is the instrument's ability to display high frequencies. As a rule, low frequencies are easier to capture and display. So prices rise with the ability to display high frequencies. You'll often see scopes specified by frequency, such as 50 MHz or 100 MHz. However, choosing and using a scope—especially a digital unit—requires more than just comparing advertised frequency range with the frequencies of signals you want to view.

On a digital scope, the ability to display frequencies depends on two things: sampling rate and bandwidth. Sampling rate is the number of input samples the instrument gathers per unit of time. You don't have to worry about sampling rate with an analog scope because the scope amplifies and displays the inputs continuously.

On a digital scope, the sampling rate limits the highest frequency the scope can display. The Nyquist sampling theorem states that to mathematically recover all frequencies that make up a waveform, the sampling rate must be at least twice as fast as the highest frequency component in the waveform.

Sampling at twice a waveform's frequency may seem like an easy enough requirement to meet. In practice, however, it's not always so simple to determine the sampling rate you need.

Shown in Fig. 2 is a pure sine wave, along with the waveform you might recover by sampling twice per cycle. The recovered waveform has the same frequency as the original, but its amplitude and phase, or timing, are different. If you want to know more about the waveform than just its fre-

quency, you need more samples.

If the original signal isn't a sine wave, finding the minimum sampling rate is more complicated. You can think of any waveform as being made up of component sine waves that, when added together, create the original waveform. Digital signals, or any signals that have sharp transitions, have high-frequency sine waves among their components. To recover all of the frequencies that make up such a signal, you need a sampling rate of at least twice the frequency of the highest-frequency component.

As an example of the foregoing, in a perfect square wave, the rise and fall times are instantaneous, or zero. The components of a such a signal are a sine wave of the fundamental frequency (the frequency at which the square wave repeats), plus an infinite set of odd harmonics of the fundamental. If the fundamental is 1 kHz, the odd harmonics are 3 kHz, 5 kHz, 7 kHz, and so on.

In reality, every square wave has finite rise and fall times. Therefore, the number of component signals isn't infinite.

A square wave is shown in Fig. 3. Sampling at twice its frequency tells you the original waveform's frequency but nothing about its shape. Sampling at ten times the fundamental frequency gives a much better picture of the waveform, though it still doesn't recreate the signal perfectly.

A digital signal that isn't a square wave is shown in Fig. 4. To be able to read the 1s and 0s that make up this waveform, you should use a sampling frequency that's great enough to take five or more samples within the shortest pulses in the signal. For example, in a 9,600-bps serial link, each bit is about 100 µs wide. Sampling at 50 kilosamples per second will allow you to recreate the signal well enough to read the data being sent.

Of course, many computer signals are much faster than 9,600 bps. On an 8051 microcontroller clocked by a 12-MHz crystal, the ALE pulse may be as short as 127 ns. To obtain a fairly accurate picture of this, you'd need a sampling rate of at least 50 to 75 megasamples per second.

In the above examples, you still know very little about the exact shapes of the signals, such as the rise and fall times at the transitions. For

this information, you would need an even faster sampling rate, as illustrated in Fig. 5. For example, the output of an LSTTL gate has a typical rise time of 13 ns, defined as the amount of time needed for a signal to switch from 10% to 90% of its final value. To obtain a display that approximates the shape of this rising edge, you must sample as fast as 400 megasamples per second. Of course, you don't always need this much information, and the bandwidth limits on analog scopes limit their performance as well.

Since scopes on expansion cards usually contain their own sampling circuits and buffers, you're not limited by the speed of the computer's bus in collecting data. Simple scopes that read the inputs directly into a parallel port can sample only as fast as the software that reads the port. Allison Technology's $190 O-Scope I connects to a parallel port and claims to have a typical maximum sampling rate of more than 100,000 samples per second.

On many two-channel scopes, you can double the maximum sampling rate and buffer size per channel by using just one channel and devoting all of the scope's resources to it.

In addition to sampling rate, another frequency specification for scopes is bandwidth. This defines the frequencies the instrument's input circuits can pass. Both analog and digital scopes have limited bandwidths, since all buffers, amplifiers and other input circuits attenuate high-frequency signals.

A scope's bandwidth is normally specified as its 3-dB point, or the frequency at which the scope will attenuate an input of a defined impedance by 3 decibels. A 3-dB drop means that the voltage is cut in half. In other words, on a 100-MHz scope, a 2-volt, 100-MHz sine wave may appear as small as 1 volt. Greater frequencies attenuate more, and lower frequencies attenuate less.

As with the sampling theorem, bandwidth defines the instrument's ability to display sine waves, not digital signals. You might think the greater the bandwidth, the better. However, in an ideal digital scope, bandwidth equals exactly twice the sampling rate. With this bandwidth, the instrument filters out any high-frequency components in the inputs that might otherwise result in an effect called "aliasing."

Aliasing can distort an input, or even cause it to appear like an entirely different waveform. An example is illustrated in Fig. 6. The sine wave is sampled at a rate that's slightly less than its frequency, and the recovered waveform is a signal at a frequency that's much lower than the original.

Computer-generated electrical noise is another consideration with PC-based instruments. The computer's digital circuits can introduce noise into the scope's inputs. Techniques for reducing noise include shielding the analog circuits and using separate isolated power supplies and solid ground planes.

Logic Analyzers

A logic analyzer is a sort of special-purpose oscilloscope that's designed for viewing only digital waveforms. Logic analyzers are especially handy for viewing multiple signals on computer buses and data links.

Like a digital scope, a logic analyzer has controls for setting sweep rate and triggering and memory for storing waveforms. As with scopes, a logic analyzer's ability to store waveforms makes it especially useful for viewing non-repeating and unpredictable signals and for viewing pre-trigger information.

Logic analyzers have important differences from oscilloscopes. A critical difference is that a scope displays exact input voltages, while a logic analyzer shows just two levels: 0 and 1, or low and high. This simplifies the display, but it can lead to misleading displays in some situations. For example, in TTL logic, a valid high input is 2 volts or greater, and a low input is 0.8 volt or less. Inputs between 0.8 and 2 volts are undefined. Thus, an input's response to them is unpredictable.

On most scopes, you can define the threshold that determines whether a signal displays as a high or a low. If you set the threshold to 2 volts, every signal equal to or greater than 2 volts will appear identical on-screen as a logic high, whether it's 2, 4 or 5 volts. Every signal of 2 volts will also appear identical, as a logic low, even though TTL logic specifies that a valid logic-low input should be 0.8 volt or less.

If the circuit is functioning properly, there will be no TTL inputs in the undefined region from 0.8 to 2 volts. But if a problem, such as two outputs shorted to each other, results in an input of 1.8 volts, for example, a logic analyzer with a 2-volt threshold will display the signal as a logic low, even though the input may interpret it as a logic high.

If you want to check for valid TTL logic lows, you must set the threshold for 0.8 volt. Then any input that's greater than 0.8 volt will display as a logic high. Because a scope displays the actual voltages, unusual voltages are much easier to spot.

Another difference between scopes and logic analyzers is the number of input channels. A typical scope has just two inputs, while most logic analyzers have at least eight, and some have more than a hundred. With this many inputs, you can view multiple data, address and control signals simultaneously. A logic analyzer's display of clock, control, address and data signals on a 68HC11 microcontroller is shown in Fig. 7.

Instead of triggering on just a specific voltage, a logic analyzer lets you trigger on a pattern, when a series of inputs matches the voltages you specify. So you can display what happens when a CPU reads from or writes to a particular address, for example, by triggering when the address lines match that address. Alternatively, you can specify a data byte and trigger when a CPU reads or writes this byte.

Some analyzers permit even more sophisticated triggering on sequences or conditions. For example, you can trigger only if Port A equals 0FFh, followed by Port B equaling A5h. Or you can specify even more-complex IF THEN ELSE branches.

As with scopes, sampling rate and bandwidth are important for logic analyzers. An analyzer doesn't require a complete ADC to sample the inputs. It needs only comparators to detect whether a signal is above or below the threshold. But the analyzer still has a sampling rate and bandwidth that limit its ability to accurately display its inputs. As with scopes, the greater the sampling rate, the better, with an ideal bandwidth of twice the sampling rate.

PC-Based Logic Analyzers

The simplest logic analyzers consist of software and a cable for reading

and displaying inputs at a PC's parallel port. A display from Logixell's $100 Real Logic Analyzer is shown in Fig. 8. Models that have wider frequency response and a greater number of channels and features usually include an expansion card that connects via cables to a logic pod to which the probes attach.

The logic pod contains the input comparators and other circuits that ensure that the pod sends clean signals to the computer. This way, the probe cables can remain short for better performance and fewer bench-top tangles.

Borge Instruments' 32100 logic analyzer places the input buffers in the pod as well. This arrangement permits a slower interface from the pod to the computer and eliminates the crosstalk and timing skew that can occur when the interface cable must carry very fast signals.

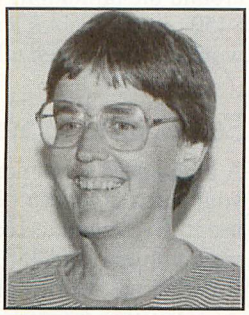
Boulder Creek Engineering's Pod-A-Lyzer employs a different approach to interfacing. Because its pod connects to the serial port, you can use the instrument on any computer that can run the instrument's *Windows*-based software.

Many of the things to consider when buying a logic analyzer are the same as for buying a scope. These include: number of channels, sampling rate and bandwidth, buffer size and user interface. Triggering options can make a big difference in how flexible and easy to use the instrument is.

Link Instruments' 28200 combined scope/logic analyzer (see lead photo) permits cross-triggering. Therefore, you can trigger the logic analyzer on an analog event or trigger the scope on a logic-analyzer event.

Moving On

Send your comments, questions, suggestions, etc. to me at Janaxel@-aol.com or by mail at Lakeview Research, 2209 Winnebago St., Madison, WI 53704. ■



Jan Axelson

PC-Based Oscilloscope & Logic Analyzer Vendors

Allison Technology
8343 Carvel
Houston, TX 77036
Tel: 713-777-0401; fax: 713-777-4746

CIRCLE NO. 130 ON FREE INFORMATION CARD

Borge Instruments Ltd.
3827 W. Ninth Ave.
Vancouver, BC V6R C2C, Canada
Tel: 604-222-3773

CIRCLE NO. 131 ON FREE INFORMATION CARD

Boulder Creek Engineering
14417 B Big Basin Way
Saratoga, CA 95070
Tel: 08-867-8170
Fax: 408-867-8179

CIRCLE NO. 132 ON FREE INFORMATION CARD

Emulation Technology
2344 Walsh Ave., Bldg. F
Santa Clara, CA 95051-1301
Tel: 408-982-0660; fax: 408-982-0664

CIRCLE NO. 133 ON FREE INFORMATION CARD

Gage Applied Sciences, Inc.
5465 Vanden Abeele
Montreal, PQ H4S 1S1, Canada
Tel: 800-567-4243 or 514-337-6893;
fax: 514-337-4317

CIRCLE NO. 134 ON FREE INFORMATION CARD

Keithley Metrabyte
440 Miles Standish Blvd.
Taunton, MA 02780
Tel: 800-348-0033 or 508-880-3000;
fax: 508-880-0179

CIRCLE NO. 135 ON FREE INFORMATION CARD

Link Instruments
369 Passaic Ave., Ste. 100
Fairfield, NJ 07004
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CIRCLE NO. 136 ON FREE INFORMATION CARD

Logixell Electronics
61 Piper Ct.
Kanata, ON K2K 2S9, Canada
Tel: 613-599-7088; fax: 613-599-7089

CIRCLE NO. 137 ON FREE INFORMATION CARD

Micro Control & Diagnostics, LLC
300 Main St., Ste. 201
Lafayette, IN 47906
Tel.: 317-429-6777; fax: 317-429-6544

CIRCLE NO. 138 ON FREE INFORMATION CARD

By Hardin Brothers

Fast Modems

What you need to know to select a modem that's right for your telecomputing needs

I must be getting old. Recently, I went shopping for golf clubs and ended up admitting to the clerk that I last bought clubs when her parents were in grade school. And when I had to pick up a new modem for one of my computers, I had to admit to myself that I bought my first modem when the technician at the store from which I was buying it was in elementary school.

Modems have changed a lot since that 300-baud, state-of-the-art unit I bought in 1978. Now it's almost impossible to buy a 300-baud or 1,200-bps modem. A few stores may have some left-over 2,400- or 9,600-bps modems in boxes gathering dust on a top shelf in their display areas or in their stockrooms. But the current norm is a choice between 14,400- and 28,800-bps modems.

The new modems run 100 times faster, use updated technologies and demand much more of the computers in which they're to be installed than those of a year or two ago. In the past, the rule of thumb was to buy the fastest modem you could afford, but even that rule is out of date. If you're shopping for a new modem or even wistfully poring through ads, you need to do some preliminary planning before you slap down your credit card and take home a new super-fast modem.

You have to be sure that your computer, your software, your telephone system and the computers you call are all compatible with the modem you plan to buy. You can check on some of the compatibility ahead of time, but the final check can be made only after you connect everything together and do a trial run. So the watchword here is: make sure you can return any modem you buy if it doesn't live up to your expectations.

The Computer

Whether you use an internal or an external modem, it communicates with your computer through a serial port. The heart of every serial port is a UART (Universal Asynchronous Receiver and Transmitter) chip that turns your computer's parallel data into a serial bit stream.

UART technology is old and turning a little gray around the edges, but it's still almost the exclusive method for connecting a modem to a computer (a very few external modems connect to a bidirectional parallel port instead of a serial port). Not all UARTs are created equal, however. Unless your computer has the proper UART, it won't be able to keep up with a modern modem.

The original IBM PC UART chip, and the one still found in many computers, is the 8450. Though this chip works well, it has one glaring weakness. It can hold only one received character at a time. At speeds up to 2,400 bps, this isn't a problem. A 2,400-bps modem typically receives 240 characters per second during a file transfer. If the computer can handle each character in 4 milliseconds, it can easily keep up with the incoming data.

If you crank the speed of the modem and UART up to 9,600 bps and use a moderately fast computer, there still isn't any real problem keeping up. Some computers can even keep up with a raw 14,400-bps data rate. But at faster speeds, lack of a UART buffer gets in the way.

The 8450 UART is sometimes replaced with a 16450 chip. Although this sounds like an improvement, functionally the two UARTs are almost identical. The first real advance in UART technology came with the 16550, which was first used in IBM's PS/2 Model 30. This chip has a 16-byte on-board FIFO (first-in, first-out) buffer, which means that well-written software can collect up to 16 bytes at once from the chip and no longer has to service a serial interrupt each time a byte arrives.

Unfortunately, the original 16550 was buggy, with the result that the buffer didn't work well. Today, almost all high-speed serial ports for IBM/compatible computers, as well as most high-speed modems, use a 16550A, 16550AF or 16550AFN UART. If you want high-speed communication, you must use one of these UART chips.

Chances are you have no idea what kind of UART chip is installed in your computer. Fortunately, you don't even have to open the system unit of your PC to find out which you have. Microsoft's MSD.EXE Diagnostic program can determine UART type for you in just a few seconds. MSD is distributed with *Windows* 3.1 and with MS-DOS 6.0 and later. So you may find it in either your DOS directory or your *Windows* directory.

To obtain accurate information about your UART chips, run MSD from DOS—not a DOS session running in *Windows* nor from *Windows* itself. (The reason for this precaution is that *Windows*' communication drivers hide the true UART type from programs running in DOS sessions.) Once you get to the main MSD screen, press C for a display of information, including UART type, about each of your serial ports.

If you don't have a 16550 UART and still want high-speed communication, you have two choices. Either you can install a high-speed serial I/O card or you can purchase an internal high-speed modem with a 16550 UART. Either way, you'll be able to work around the limitations of a slower 8450 or 16450 UART and enter the world of high-speed telecomputing.

Software Connection

A high-speed serial port is useless if your software doesn't know how to use it. By default, a 16550 UART will simply mimic an 8450 chip. So old software will work well, but it won't

be able to take advantage of the FIFO buffer. Of course, used in this mode, a 16550 is nothing more than a glorified 8450, and you can't use any of its advanced features.

Using a fast modem requires fast, sophisticated software. If you want to run at 14,400 bps or faster, it's time to retire that ancient copy of the original shareware *ProComm* you've been using all along and look for a program that has fast serial support.

If you use *Windows* 3.1 or later, you're in luck. *Windows* does the low-level work of handling the UART chip and other serial-port subtleties. The serial drivers included with *Windows* 3.1 (but not those in *Windows* 3.0) should work just fine. You can also find replacement serial drivers for *Windows*, both as commercial products and shareware, that can slightly boost the performance of your modem. If you use *Windows for Workgroups* 3.11, *Windows NT* or *Windows 95*, you shouldn't need replacement serial drivers.

Don't try to run your DOS communications under *Windows* 3.1. As I already mentioned, the default serial drivers supplied with *Windows* hide the true nature of the UART from DOS programs run in either DOS sessions or directly from File Manager or Program Manager. *Windows* knows you have a 16550 UART, but your DOS program will think you're using an 8450 chip. You'll obtain better results with a DOS communications program that understands how to use a 16550 UART, if you run it from a "pure" DOS prompt when *Windows* isn't running.

If you use *Windows* 3.1, the last step is to edit its SYSTEM.INI file to enhance high-speed communication. The chart in the "Configuring *Windows* 3.1 for Fast Communications" box shows the settings most users prefer.

The Modem

Start with a 16550 UART, add communications drivers or software that has the ability to use it and then add a high-speed modem. Bear in mind that selecting a modem can be more difficult than choosing a new computer. While UART and communications software technology are reasonably straightforward, modems are decidedly not.

The world of modems seems to bounce from standard to standard, from feature to feature and from brand to brand. Often, a modem package will have a long list of "standards" the modem meets. Since these standards define the modem's operating features, it's best to start with them.

When modems were first introduced, it was illegal to connect non-Bell equipment to most U.S. telephone lines. Instead of buying an extension phone from K-Mart, you had to rent a phone from the telephone company and pay for a technician to install it. The only telephone-line modems available also came from the telephone company.

Even after it became legal to attach other equipment to the telephone lines, almost all U.S. 300-baud mo-

Configuring *Windows* 3.1 for Fast Communications

Edit the [386Enh] section of SYSTEM.INI to include these values. The COM settings assume your modem is connected to COM2. Change them appropriately if you're using a different serial port:

MinTimeSlice=20	Sets minimum time a virtual machine is allowed before another task takes over.
WinTimeSlice=100,50	Sets relative amount of processing time given to all *Windows* applications in foreground and all those in background).
COM2Protocol=	Make sure this setting is blank or the line doesn't occur in your .INI file. Setting it to XOFF interferes with binary data transfers.
COM2FIFO=1	Turns on FIFO buffer in 16550 UART. Has no effect on other UARTs).
COM2Buffer=1024	Sets buffer size for indicated serial port. Default size of 128 is too small for most high-speed data transfers.

If you have problems, here are ways you can try to improve high-speed communication in *Windows* 3.1:

(1) Be sure you're using a 16550 UART for your communication port (see text).
(2) Switch to *Windows for Workgroups*, which has better serial architecture than *Windows* 3.11.
(3) Disable screen savers during file transfers. These can interfere with communications programs.
(4) Don't run your serial port any faster than necessary. 38,400 bps is usually fast enough for a 14,400-bps modem and 57,600 bps is usually sufficient for a 28,800-bps modem. Rarely will V.42bis compression outpace these speeds.
(5) If possible, use "hardware flow control" on both local and remote modems instead of XON/XOFF or other software flow control.
(6) Disable write caching on your download hard drive. Write times can interfere with communication flow.
(7) Use COM2 instead of COM1 for your modem because COM2 has higher priority than COM1.
(8) Beware of TSRs, network connections, SCSI drivers, out-of-date BIOSes and poorly-written device drivers, all of which can steal time from communication software. Update to the latest versions, if possible, or boot without them for high-speed com munication.
(9) Be careful of memory managers, like QEMM's *Stealth*, that steal processor time.
(10) If necessary, look for third-party replacements for COMM.DRV, the serial-port driver in *Windows* 3.1.

dems followed the Bell 103 standard and 1,200-baud modems followed the Bell 212 standard. A Bell 212 modem was really two machines in one because it included the ability to work at both 1,200 bps (following the 212 standard) and at 300 bps, depending on the capabilities of the modem at the other end of the line.

The concept of two modems "negotiating" for the fastest rate and the greatest number of features possible on a given connection has made possible mass modem communication, BBSes, on-line services, etc. Without modem negotiation, each on-line service would need a separate line and telephone number for every modem speed and feature set it wanted to support.

Europe didn't follow nor accept the Bell standards for 300- and 1,200-bps modems. Outside the U.S., low-speed modems follow CCITT V.21 (0 to 300 bps) and V.22 (600 and 1,200 bps) standards. The Bell and CCITT standards led to completely incompatible modems and, therefore, tended to isolate U.S. data transfers from the rest of the world, except via on-line services like CompuServe.

Because of the Bell proprietary standards, lack of competition and dearth of modem chipsets, modems were expensive and slow through the early 1980s. But by the mid 1980s, Rockwell and other manufacturers started producing chipsets that met the CCITT's V.22bis standard for 2,400-bps communication. These chipsets also were downward-compatible with Bell 212 and 103 modems or with V.22 and V.21 modems.

The chipsets led to two important revolutions in the modem industry. First, they contained the difficult engineering and left the details of interfacing and other technical matters to an OEM. It was possible for any reasonably talented engineering company to start making modems, and many did. Second, everyone could communicate at V.22bis, which meant that the effects of the Bell *versus* CCITT low-speed standards were coming to an end.

The 300-, 1,200- and 2,400-bps standards are all "asynchronous," which means that no common clock pulse is shared by the modems at either end of the telephone line. Instead, each byte is sent in a wrapper that includes one start bit and one or more parity and stop bits. This adds a significant overhead to data transmissions. For example, the common setting of 8N1 (eight-bit data bits, no parity bit and one stop bit, plus an implied start bit) requires 10 bits per byte. To send one byte at these settings, a modem must actually send 10 bits. At 2,400 bps, maximum throughput, then, is 240 bytes per second.

Even though 2,400 bps seemed fast when V.22bis modems were first introduced, users always want more speed and manufacturers are always trying to accommodate them. Also, as speeds increased, users wanted more data accuracy. At 300 bps, it's easy to spot an error in text as it slowly scrolls across the screen. At 2,400 bps, spotting errors is almost impossible.

One of the first companies to respond to this demand was Microcom, which developed a series of MNP (Microcom Network Protocol) standards for Microcom-compatible modems. MNP Levels 2, 3 and 4 have become *de-facto* standards for hardware error control and are built into most modern modems.

In 1988, the CCITT caught up with Microcom and issued standards V.42 for hardware error control. V.42 really is a double standard. Modems that are completely V.42-compliant use Link Access Protocol for Modems (LAPM) for hardware error control. They can also use MNP-4 when they connect to modems that don't support LAPM.

Modem Standards

These standards apply to modems that are designed for use over normal analog switched voice telephone lines. Other standards exist for modems designed for leased and dedicated lines.

Bell and CCITT Modem Protocols

Bell 103 U.S. standard for 300-bps modems.
V.21. World (non-U.S.) standard for 0-to-300-bps modems.
Bell 212. U.S. standard for 1,200-bps modems.
V.22. World (non-U.S.) standard for 1,200/600 bps modems.
V.22bis. International standard for 2,400-bps modems.
V.32. International standard for 9,600-bps modems with fallback to V.22bis.
V.32bis. International standard for 14,400-bps modems with multiple fallback speeds plus compatibility with V.32 and V.22bis.
V.FC. Interim and outmoded standard for 28,800-bps modems.
V.34. International standard for 28,800-bps modems plus compatibility with V.32bis, V.32 and V.22bis.
V.34bis. Standard under development for 33,600-bps modems.
V.42. Hardware error correction protocol improves on and includes support for MNP Level 4.
V.42bis. Hardware data compression that's significantly better than MNP Level 5 compression.
Note that V.42 and V.42bis are independent of transfer speed and can be used on modems that transfer data at any recognized speed.

Microcom MNP Protocols Levels 1 through 5

(MNP Levels 6 through 10 are rarely available, except on Microcom modems.)
MNP Level 1. Uses asynchronous byte-oriented half-duplex transmission that provides 70% efficiency. 2,400-bps MNP Level 1 modem has throughput of about 1,690 bps.
MNP Level 2. Uses asynchronous byte-oriented full-duplex transmission with 84% efficiency. 2,400-bps MNP Level 2 modem has throughput of about 2,000 bps.
MNP Level 3. Strips start and stop bits from asynchronous data to enable synchronous bit-oriented full-duplex transmission. Efficiency is about 108% (2,600 bps on 2,400-bps modem).
MNP Level 4. Adds adaptive packet assembly and Data Phase Optimization plus hardware error correction for about 120% efficiency (about 2,900 bps on 2,400-bps modem).
MNP Level 5. Adds data compression to Level 4 service. Provides average data compression ratio of 1.6:1, increasing average efficiency to about 200% (4,800 bps on 2,400-bps modem).

To send more data through the same-speed modem, Microcom developed a data-compression standard it called MNP-5. CCITT responded with V.42bis, which is a significant improvement over MNP-5. If you use MNP-5 compression, you should turn it off when you send pre-compressed files like those with .ZIP, .LHA, etc. extensions through the modem because it can actually slow down transmission of these files. V.42bis won't slow down transmission of these files and usually produces better compression than MNP-5. Many modems that support V.42bis compression also offer MNP-5 as a fall-back to retain compatibility with older modems that don't support the V.42bis standard.

It's important for you to understand that MNP, V.42 and V.42bis are independent of actual transmission speed. These protocols are all offered in 2,400-, 9,600-, 14,400- and 28,800-bps modems. With highly compressible data, V.42 and V.42bis can often quadruple transmission speed, compared to a straight data link. Used with the right data on a 28,800-bps link, for example, it's sometimes possible to transmit data at a rate of 115,200 bps. But the key word here is "sometimes" because most data isn't that highly compressible.

MNP-4 and V.42 hardware error correction have one additional benefit. Instead of wrapping each byte in control bits, they send data in 16- or 32-bit (for V.42) packages accompanied by a CRC (cyclic redundancy check) value. The receiving modem also calculates a CRC on the data and, if the two values match, accepts the packet as error-free. More importantly, the packets reduce the amount of overhead on the line and result in about a 22% increase in data throughput. Add to this the compression that results from MNP-5 or V.42bis, and you can often double a modem's effective speed.

To make use of V.42, V.42bis and their corresponding MNP protocols, your computer's link to the modem must be faster than the modem's link over the telephone line. Modems that follow these protocols invariably permit fast links to the computer, usually at speeds that are at least double those of the modem itself. That is, you'd normally set your COM port and communications program to 4,800 bps for a 2,400-bps modem, at 19,200 for a 9,600-bps modem, and so on. You may not be able to achieve data transfers at these speeds, but if you set communication speed lower, you may slow down part or all of a data transfer.

Faster Modems

Modem speed is limited by the telephone line. For a while, 2,400-bps (V.22bis) modems with V.42 and V.42bis hardware error correction and compression seemed to bump against this limit. Faster modems were available for leased and dedicated lines but not for normal switched telephone lines. But introduction of V.32 modems in the late 1980s has led to dramatic increases in modem speeds.

V.32 defines a standard for 9,600-bps modems with a fallback to V.22-bis rates. What this means is that if the modems find that line quality doesn't support 9,600-bps throughput, they agree to reduce their speed to 2,400 bps, at least until line quality improves.

V.32 breaks new ground in two important ways. It's the first popular standard for switched telephone lines that uses synchronous instead of asynchronous transmission; and it's the first standard to make use of automatic echo cancellation to support fast, bidirectional data transmission.

Unlike earlier systems, V.32 modems place data on a constant timing pulse. To indicate data, they modulate each pulse by both phase and amplitude. Pulses run at 2,400 baud (state changes per second), which is near the theoretical maximum for a U.S. switched telephone line. Each pulse can be modulated to indicate one of four data values. Hence, data can be sent at four times the baud rate, or 9,600 bps.

To achieve reliable 2,400-baud signal communication, the modem must use nearly all of the 3,000-Hz bandwidth available on a switched telephone line. For both modems to send data simultaneously, both must use almost all of the bandwidth of the line. To accomplish this, a V.32 modem uses automatic echo cancellation, which means that it filters the echo of its own pulses from the tones it receives to "hear" the modem on the other end of the line. In other words, the modem must be able to erase the

Expected File-Transfer Times for Various Modems

Times given here are based on a 1M-byte file and assume no retries, re-timing or re-synchronization of modems and no pauses due to multitasking or disk accesses on either side of the line. Times using V.42bis data compression are extremely optimistic and assume the most-compressible data possible (occasional spreadsheet with lots of empty cells can be compressed 4:1, for example). All times are rounded up to the nearest second.

V.22bis 2,400-bps modem (240 bps):
72 minutes 50 seconds
V.32 9,600-bps modem with V.42 error correction (1,440 bps):
12 minutes 9 seconds
V.32bis 14,400-bps modem with V.42 error correction (2,160 bps):
8 minutes 6 seconds
V.32bis 14,400-bps modem with V.42bis data compression (7,200 bps):
2 minutes 26 seconds
V.34 28,800-bps modem with V.42 error correction (4,320 bps):
4 minutes 3 seconds
V.34 28,800-bps modem with V.42bis data compression (14,400 bps):
1 minute 13 seconds

tones it created and the background noise from the signal it receives over the line. Once it has done this, it has the signal sent by the remote modem.

The one weakness of V.32 is that it offers only one fallback rate—to 2,400 bps, V.22bis speeds and protocols. Ratified in 1991, the V.32bis standard defines modems that run at a top speed of 14,400 bps. To do so, they pack six data bits plus one redundant bit used for error checking into each pulse, producing 6 X 2,400, or 14,440-bps throughput. The V.32bis standard also defines fallback speeds of 12,000, 9,600, 7,200 and 4,800 bps, as well as compatibility with the V.32 and V.22bis standards.

A 14,400-bps V.32bis modem should operate at top speed on any POTS (plain old telephone service) line in the U.S. For most lines, such a modem will work well. If your line is consistently too noisy for a 14,400-bps connection, it may be time to ask your local telephone company to test it. Before you do, however, make sure the problem isn't caused by your local wiring.

If possible, disconnect your home or business telephone wiring completely from the terminal block that connects the telephone company's wires to your wires. Then connect your modem's line directly to the terminal block. Be sure you're trying to make connection to a modem that's normally accessible to others at 14,400 bps.

If you can make a good 14,400-bps connection under the foregoing circumstances, you may have a cheap telephone instrument or fax machine on your line or substandard wiring that's degrading the modem's signal before it leaves your premises.

The easiest way to test for a faulty component is to disconnect everything and then restore each telephone instrument, fax machine, answering machine, etc., to the line one at a time. It shouldn't take too long to isolate any device that's causing problems.

If you want to connect to the Internet's World Wide Web with a graphical browser like *Mosaic* or *Netscape*, 14,400 bps is just about the slowest acceptable speed. Many users want graphics and large files to appear on their screens more quickly than this. The V.34, 28,800-bps modem was invented just for such people.

Because of engineering difficulties, it took CCITT longer than expected to define and ratify V.34. In the interim, several manufacturers defined and implemented a standard called V.FC (for Fast Class) to give their customers 28,800-bps service. About a million V.FC modems were sold, none of which is compatible with the V.34 standard. Many of these can be upgraded by installing a new ROM chip or downloading a new operating program into the modem's non-volatile RAM (NVRAM). If you have a V.FC modem, check with the manufacturer to see if you can upgrade it to true V.34 compatibility.

There's a theoretical limit to the amount of information that can be transmitted over any line. The limit is based on bandwidth, power and background noise. At first, engineers thought 28,800 bps was theoretically impossible over most U.S. telephone lines. But the increasing amount of fiber-optic cable now strung between telephone switches makes 28,800-bps communication sometimes possible. However, the old copper cable running from your home or office to the telephone company's switch and from the remote modem to another switch, may make the line too noisy for 28,800-bps communication.

Many owners of V.34 modems find that they often have to settle for slower transmission rates because of the limitations of voice telephone lines. Usually, they can run above 18,000 bps, but rarely can they run at a full 28,800 bps.

One additional feature of the best V.34 modems is that data flow can be at two different speeds—one for transmission from modem A to modem B and another for transmission from modem B to modem A. Split speeds permit the modems to adapt to vagaries in the telephone line and switches and transfer data most efficiently, even when transmission clarity is better in one direction than in the other.

Are faster speeds coming? Perhaps. An industry group is now working on a V.34bis standard for 33,600-bps transmission. However, they believe this will be usable on only the best telephone lines. Also, the forthcoming standard will probably be the last for analog voice telephone lines.

Most engineers and industry observers believe that we'll have to wait

for digital, ISDN phone lines for the next big jump in data-transmission speed. (ISDN should bring an immediate jump to 64K bps, but only if both modems are attached to ISDN lines.)

Selecting a Modem

So you want a V.34bis, 33,600-bps split-speed modem with V.42 and V.42bis error correction and compression, along with MNP-everything compatibility. This is what we'd all like, except that V.34bis modems don't exist yet.

Realistically, though, what's the best modem for you? If you want to connect to another 28,800-bps modem and you know that others can connect to that modem at full speed (it isn't sitting on an old and deteriorating copper line), a V.34 modem with V.42/MNP-4 error correction and V.42bis/MNP-5 compression is your best choice. However, make sure you can return the modem if it doesn't work out. If you want an external modem, make sure your computer has a 16550A, 16550AF or 16550AFN UART. If you don't, you can either install a new serial I/O card or try an internal modem that has its own 16550 UART chip. Crank your terminal program up to 115,200-bps communication speed with the modem, and move over to the fast lane. You'll have the fastest affordable communications available today.

If you don't need such blazing speed, look for a 14,400-bps V.32bis modem with the same error-correction and compression capabilities. Again, be sure you have a fast UART or buy an internal modem (and make sure it has a 16550 UART). Set your terminal program for 57,600 bps if you want to make sure you get every last ounce of performance from your modem.

As I write this, reasonably good internal 14,400-bps modems have street prices of about $150, and 28,800-bps modems cost about $125 more. Quality in these fast modems is important. Pay a little more for a reputable manufacturer that will support the modem and upgrade the ROMs or NVRAM program when necessary. A flaky 2,400-bps modem may get by on most telephone lines, but a flaky 28,800-bps modem never will.

Is it worth your while to upgrade? This depends on how often you use your modem, what services you use, how much data you receive or send, whether you call long distance and how much you pay for services. Generally, you can expect an ideal 28,800-bps modem to transfer data 25 times faster than a standard 2,400-bps modem. If the data is highly compressible (spreadsheets often compress the most), the speed may be twice as fast. If you're paying long-distance and on-line charges by the minute, the upgrade may pay for itself in only a month or two.

On the other hand, if you use your modem for only e-mail on a local flat-rate system and if you rarely if ever transfer a full file, it may be silly to upgrade. Hold on for another year, and prices are certain to drop as features and speeds increase. For me, a high-speed modem is a worthwhile investment, even though I rarely call long distance and I spend most of my time on flat-rate services. The convenience of being able to quickly move large amounts of data justifies the cost of a fast modem.

It's difficult to clearly recall the excitement I felt when I first connected to another computer with my original 300-baud modem. Suddenly, my computer could talk to the outside world and I soon discovered BBSes, on-line services and even some early interactive modem games. Today, being on-line seems like a normal part of computing to me and millions of other computer users. The real excitement comes from having one of the fastest, most-responsive communication systems on the block. ■

Bits 'n' Pieces By Alexander W. Burawa

V Communications *System Commander* 2.09 Lets You Choose From Among Multiple Operating Systems on a Single PC

If you're leery about moving from the DOS/*Windows* operating environment with which you've become comfortable to another of the OSes available for Intel-compatible computers, you're not alone. Almost everyone who anticipates a move to *Windows 95*, *Windows NT*, OS/2 *Warp*, any of the various flavors of Unix for x86 and Pentium computers and others has good reason to be ambivalent about working under a new OS. Such a move can trash an OS and possibly even program and data files installed and created under DOS or/and *Windows*. If you didn't take the sage advice of backing up your hard disk before making the change, you have to start all over from square one.

To be on the safe side, you need a way of installing a new OS that will guard your existing operating environment from damage until you've had time to check out whether new environment is for you. Enter V Communications with its *System Commander* 2.09. With it, you can have multiple OSes—multiple versions of DOS, *Windows*, *Windows 95*, *Windows NT*, OS/2 *Warp* or any other Intel-compatible operating environment—up to 32 in the boot partition (and up to 70 accessible from primary or logical partitions on up to 14 hard drives of any size)—on your PC and choose which one you want to use at boot-up. By keeping each OS apart from all the others on your hard disk, *System Commander* takes the worry out of trying out new OSes.

With *System Commander*, you can install and try out, say, *Windows 95* to determine if it's for you. If not, you can eliminate it and return to the operating environment you were using prior to the new installation. Specific instructions are given on how to protect your existing OS from the predatory nature of *Windows 95*. Alternatively, if you have a need to run under different operating environments or configurations at different times on the same PC, *System Commander* provides a safe way of doing it.

Once it's installed on your PC, *System Commander* takes control of your PC at boot-up before any OS runs. As your PC begins the boot process, you're presented with a menu of choices for the operating systems you have

(Continued on page 94)

By Tom Benford

Non-Linear Video Editing on a PC

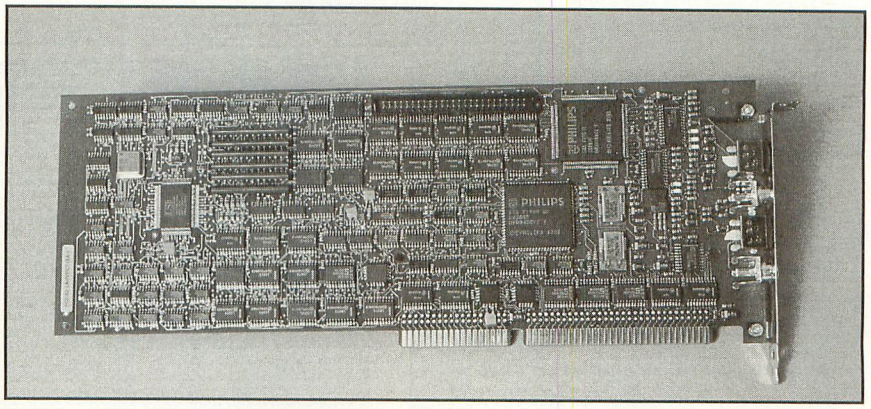
Miro's Motion MJPEG card and video mouse combo make VHS-quality digital video possible, practical and affordable

Most folks do basic linear editing by transferring scenes in the desired order from their camcorders to their VHS VCRs, using the camcorders' fast-forward and rewind controls to shuttle to scenes, as required. While this approach is certainly the most-economical way to edit video, it has some distinct disadvantages that, depending on your requirements, may be significant.

Since videotape is an analog recording medium, anytime you make a copy of the tape (or "dub," as its known), the resulting copy has visible image degeneration that's caused by signal loss and dropout. While some formats (for example, Betacam, Hi-8 and S-VHS, in this order) are less susceptible to degeneration than standard VHS, VHS-C or 8 mm formats, there's always going to be some signal loss that degenerates the quality of copied images.

Every time a videotape is played, the media comes into contact with the rotating video head, which also results in signal loss as the tape's magnetic particles are lost through the friction produced by this action. The more frequently a tape is played, as when you're trying to locate desired edit-in and edit-out points, the more the original image information is degraded. Signal loss is compounded when you use visible search, since the tape is shuttled over the video head(s) at accelerated speed.

Videotape is subject to stretching through repeated use, especially when frequently played, fast-forwarded and rewound. Repeatedly shuttling a tape back and forth while searching for a scene is a surefire way to induce stretching, which becomes noticeable as a wave or rippling of the image in a scene as it's played. Once you have a rippled image caused by stretching, there's no way to eliminate it.



VRAM, Philips encoder and decoder and 64702 JPEG processor chip are visible in this shot of Miro DC1 card. There are no DIP switches or jumpers to preset, since all configuration is done via software.

If you need more than one copy of an edited tape, there are some additional things with which to contend. If you make copies of the edited copy, which is already second-generation, the image quality deteriorates considerably more. If you want to maintain second-generation quality, you must prepare another edited tape, again using the camcorder's original footage. In turn, this puts more wear and tear on the original tape.

Then there's the whole subject of adding titling and special effects, such as dissolves and other transition effects. Straight linear editing from your video source to a copy deck won't be adequate or capable for such chores.

Digital editing eliminates all of these problems and it gives you the freedom of randomly accessing any portion of a scene without constant rewind and fast-forward shuttling. You can also change the order of your assembled edit to insert a scene between two existing scenes, add titling or overlay material or use a transition effect so that nonlinear editing becomes a practical reality.

I've covered the subject of capturing, digitizing and editing video under *Windows* to produce .AVI (audio video interleaved) files both here in the May/June 1995 issue of *MicroComputer Journal* and in much greater depth and detail in my book, *Introducing Desktop Video*. However, this coverage was devoted entirely converting analog video into digital format for editing and manipulation. The final finished format, however, remained digital in the *Video for Windows* .AVI format files. Intel's Smart Video Recorder Pro and other popular digitizing video-capture cards can't export the digital production back into analog format for recording on a VCR or displaying on a TV receiver's screen.

Miro's DC1 card does have this

Asymetrix 3D F/X software makes dazzling 3D effects a drag-and-drop procedure for less than $100

I once heard an adage that stated, "anyone who works harder than he has to is a fool." The underlying meaning wasn't that you should be lazy or unindustrious, but that if you can achieve the desired result without going through unnecessary effort, this is the way to go. That old bromide has stayed with me through the years. Today, it seems to ring truer than ever when it comes to producing multimedia effects on a computer.

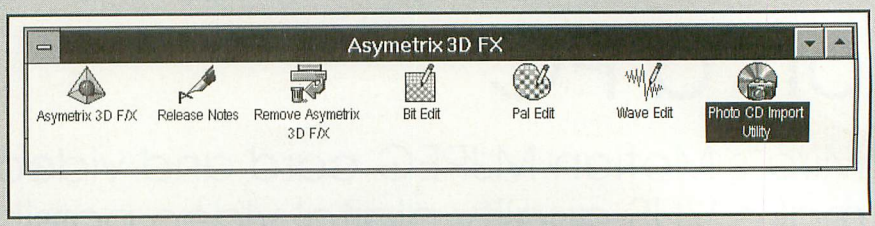
Sophisticated graphics and special-effects packages that run under *Windows* have been around for quite a while now, but these programs have traditionally been aimed at the high-end user and carried steep price tags of $700 or more for the snap and sizzle they could deliver. Thanks to the popularity of *Windows* and the general higher profile computers have taken in recent years, just about everyone is conscious of the graphics, animations and special effects that have become a commodity component of TV, motion pictures and advertising. As a result, everyone's expectations of how visual material should be presented have risen dramatically. This being the case, business presenters, graphic designers and CD-ROM publishers must work more diligently to meet these expectations with increasingly attractive, eye-catching visuals in their final products. But software tools are available to make producing stunning 3D visual effects less laborious.

Graphics Tool For Everyone

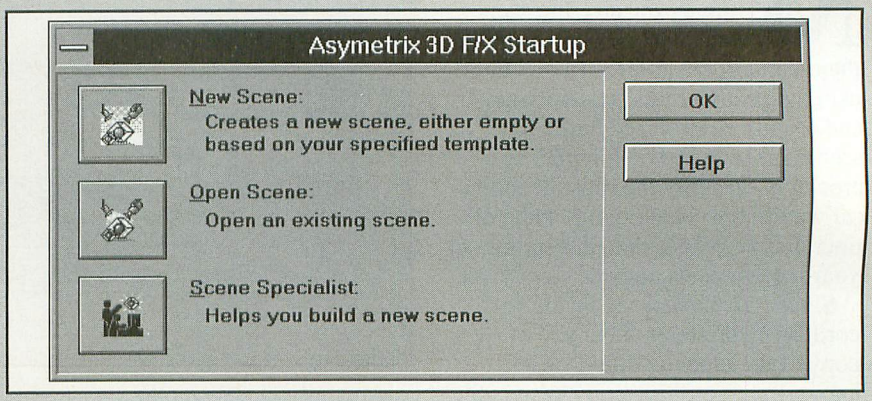
Asymetrix has risen to the call with release of its *Asymetrix 3D F/X* package that satiates the need for an innovative, easy-to-use graphics tool for creating professionally generated 3D images and animations, yet doesn't cost thousands of dollars or require exotic hardware and extensive training to use. The package is a true drag-and-drop application that presents cascading menus and a catalog of choices from which you make your selection and drag it to the desired area of the program.

When you finish making all of your choices, you click on a generate button, and in an amazingly short time, you have a completely rendered 3D graphic or animated sequence that's truly eye-catching. Along the way, you get to see realtime, solid-model previews of the production. So nothing is left to the imagination.

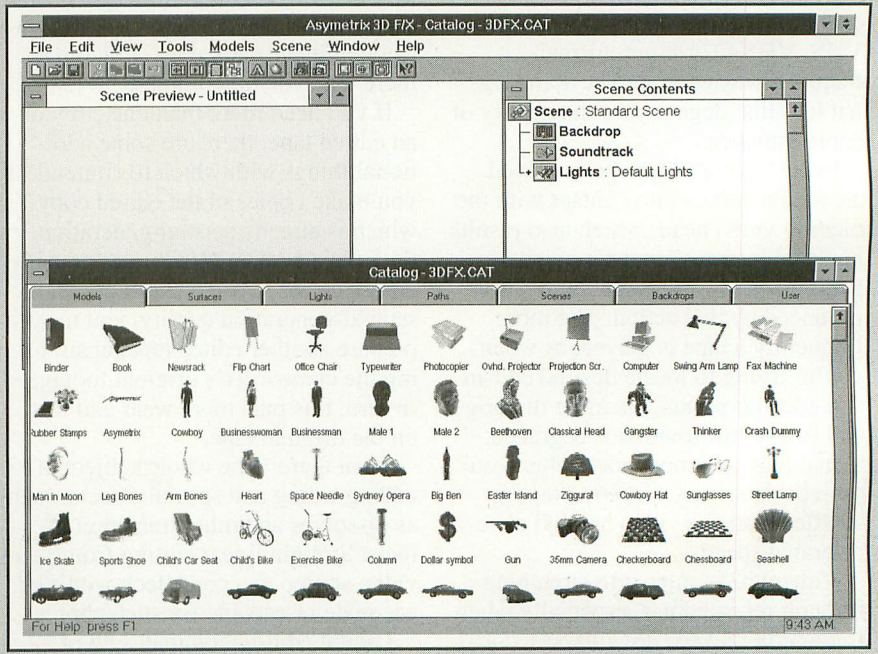
Having used several of the high-priced, high-end packages currently available for generating 3D effects and



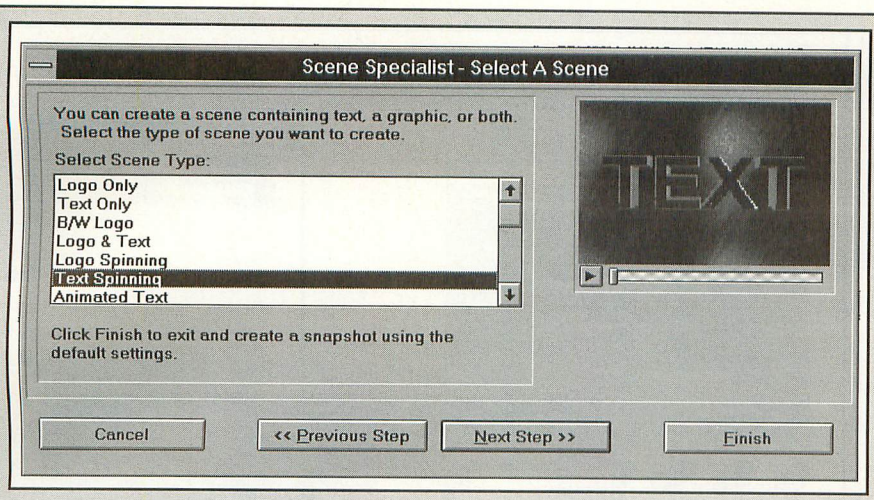
Program group and applet icons created by *Asymetrix 3D F/X*. In addition to main *3D F/X* application, bitmap, palette and wave-editing applets are additional nice touches that permit extensive file modification. Photo CD Import utility is very handy for converting .PCD images into formats for use as backgrounds —or models—with program. Uninstaller is also included should you ever want to remove *3D FX*, and release notes contain late-breaking news and tips.



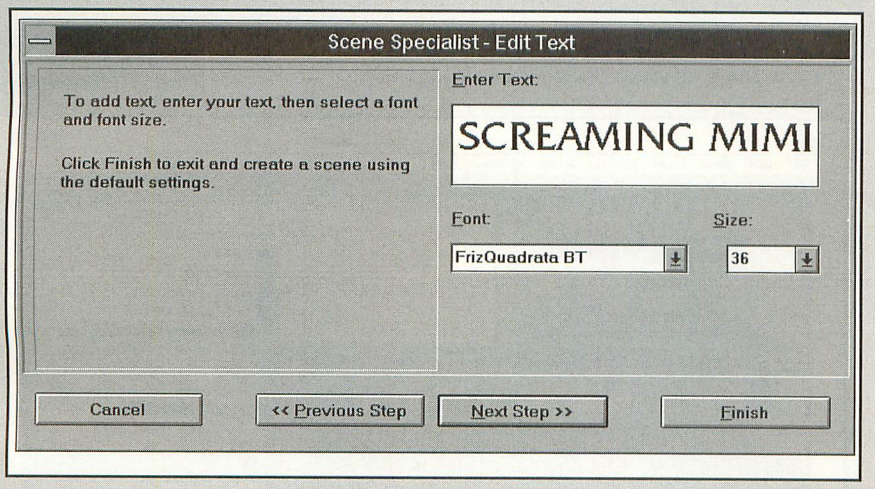
From startup screen, you choose to build a scene from scratch, call up an existing scene or use Scene Specialist to guide you through process of building a scene and generating finished 3D graphic or animation.



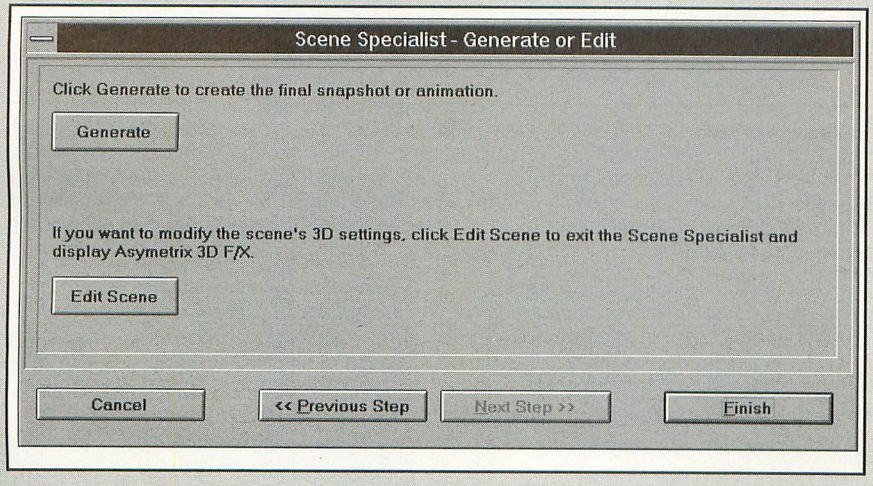
Small portion of the "models" section of *3D F/X* catalog is shown here. Using drag-and-drop routines, you simply select model you want to use and drag it into scene. In like manner, you can select scene background, lighting effects, movement paths, surface textures and more from choices given or add your own elements into "user" tab of catalog.



First step in using Scene Specialist is selection of type of scene to create from choices given. then click on Next Step to proceed. You can also click Previous Step to backtrack and change choices made earlier in process, if desired.



Font, size and text are entered using any desired *TrueType* font installed on system. Primary function is to get basic text into scene, although you can change positioning, colors, bevel types and other attributes by editing scene later.



Final screen in Scene Specialist lets you generate or edit scene. From here, you can also regress to an earlier screen by clicking on "previous step" button.

animations, I have a good practical knowledge base to use as a standard of comparison. I suppose this is why I'm so impressed with *3D F/X*. It does 90% of what the "pro" packages do, but it does it easier, faster and less expensively. The super-esoteric effects that it doesn't support are ones I've never used or needed. So chances are pretty good you'll never miss them, either.

3D F/X is supplied on CD-ROM and installs from *Windows* by running the "setup" application from the Program Manager File menu. You're given a choice of storing the catalog files on your hard drive or keeping them on CD-ROM. The latter, of course, conserves hard drive space but makes for slower-operating sessions. The installation program builds a new program group and adds program icons.

Generating 3D Animation

The best way to describe how easy *3D-F/X* is to use is to do a complete run-through of generating a 3D animation. I'll start at the very beginning.

Upon launching the program, you're greeted with the Startup screen that gives you the choice of building your scene from scratch, calling up an existing scene or generating a scene with a "wizard"-type selection called Scene Specialist. This option leads you through each step of scene building by prompting you for the required selections to complete the operation. Although the choices given by Scene Specialist are less flexible than free-form construction, it does give instant gratification without your even having to open the manual.

You can use an extensive "catalog" of 3D scene elements, provided in the package, to construct scenes and animations. In addition to backdrops that form the basic background for a scene, you're given lots of already-rendered models to use as well. Other catalog choices include selections for different lighting effects, movement paths, already-constructed scenes, surface-texture maps and a separate "tab" that permits you to store your own elements.

Using Scene Specialist is the fastest way to get up and running, although the choices it provides are more restricted than free-form scene construction. It's an excellent and extremely fast way to generate simple projects and to give you the basic idea of what the program can do. In the following example, I've opted to use Scene Specialist to create the basic framework for the scene, but I also did some manual editing to give things the custom touches I wanted to add.

capability, which is the focus of this article. The benefits of using this card are many, starting with the fact that you're utilizing first-generation video source material that can be manipulated and processed to your heart's content on your computer, including addition of titling and special effects, then exporting it back to videotape with no apparent loss of image quality. The secret of how it accomplishes this is its MJPEG compression and decompression capabilities. In addition to the NTSC export capabilities the MJPEG scheme permits, the card is also compatible with *Video for Windows* (.AVI) and *QuickTime for Windows* (.MOV) formats.

The DC1 is a very densely-populated three-quarter length card that has no jumpers or DIP switches that need to be to set. Everything is software-configurable on this card. The card's mounting bracket features both composite and S-video phono-jack connectors for video input and output. The card installs in any available 16-bit ISA, EISA or VL expansion slot on a PC's motherboard.

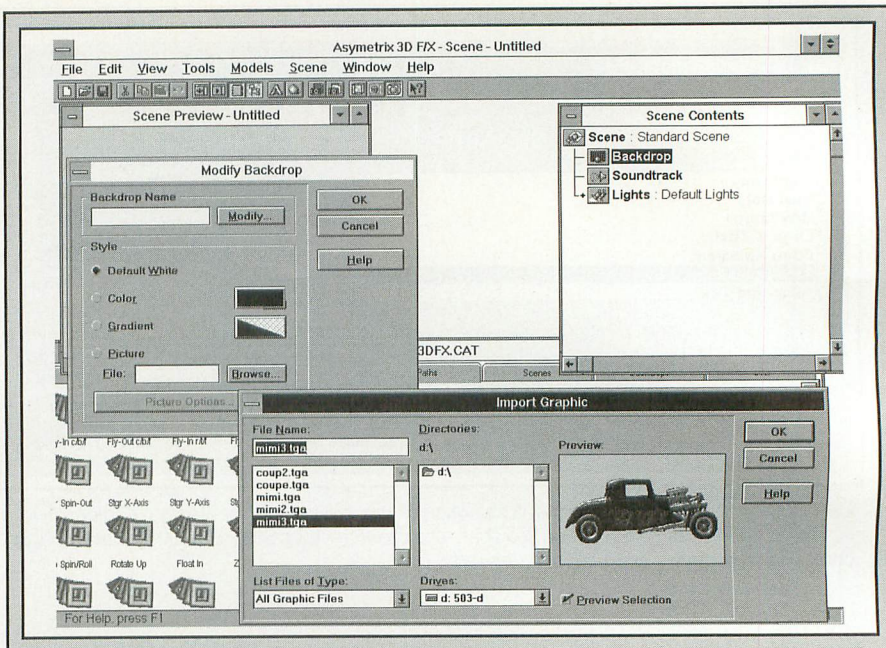
In addition to the DC1 card, a well-written user's manual and a 3½" diskette with required driver software are provided. Also included is a Limited Edition version of *Adobe Premiere* on CD-ROM and a copy of *Crystal Flying Fonts Pro* software.

Hardware installation consists of plugging the card into a suitable motherboard slot, securing the end bracket with a screw, closing the PC's system unit and connecting one cable from a video source and another to a video destination device, such as a TV receiver or VCR. The remainder of the installation is accomplished via software.

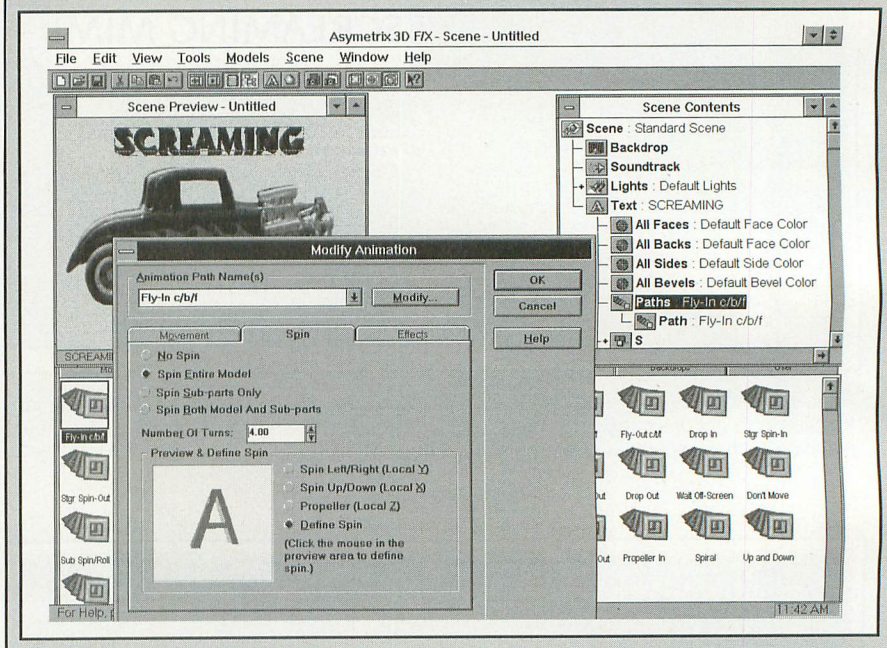
The DC1 doesn't have its own video application software. Instead, it relies on a video package like *Adobe Premiere* for video capture, editing and exporting. The diskette contains the Miro Video-XL compression driver and a hard-disk speed-checking utility called HDSPEED.EXE. This utility lets you confirm that your hard drive has a sufficient data-transfer rate to accommodate the video data stream.

Speed is Crucial

Capturing a one-second video sequence at medium quality produces a



Selection of backdrop is shown here, with the mimi3.tga Targa graphics file as selected graphic to be imported. By clicking on Preview Selection checkbox on Import Graphic screen, you can see what your selected image looks like.

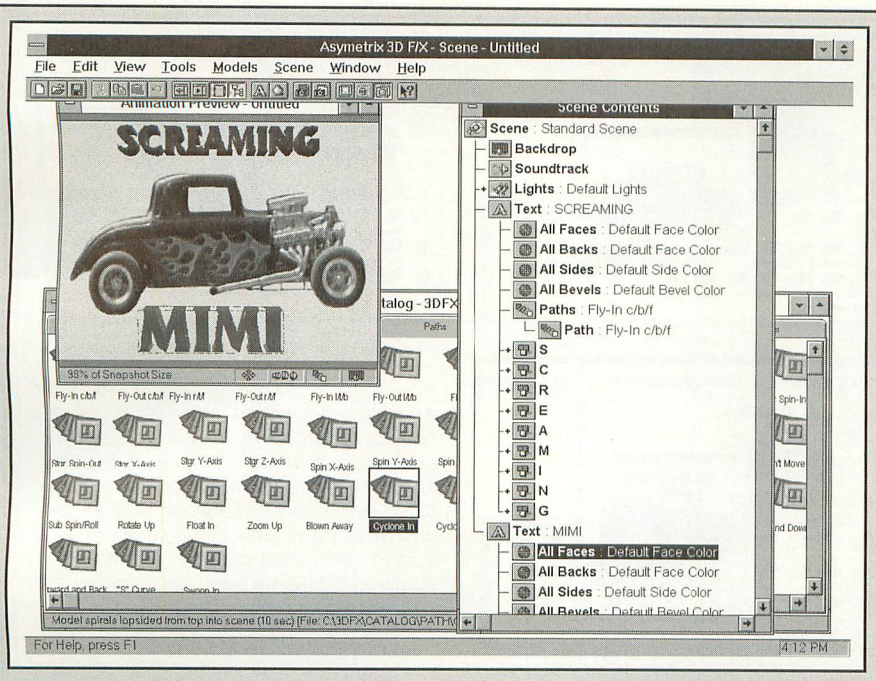


Since both text elements—SCREAMING and MIMI—were split into independent text models, options and treatments for each could be unique to each other. These options include, among other things, directional path animation for each is to take. For SCREAMING, animation path selections are a fly-in from center-bottom-front, with entire word spinning four turns for duration of animation. Same procedures are used to select attributes and animation path for MIMI.

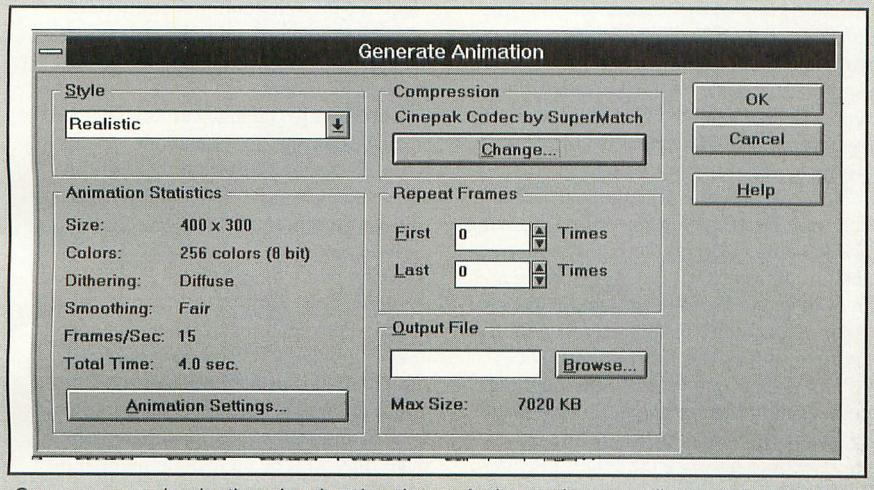
I started by selecting Text Spinning as my scene type. The next screen prompted me to enter my text, "SCREAMING MIMI," which I did. At this point, I also selected the font and type size I wanted to use. By clicking on the "finish" button, all of the program's default choices would be invoked and the scene would be created. Instead, I clicked on the next step button to progress further into Scene Specialist.

The final Scene Specialist screen gives the options to generate the finished project, whether it's a 3D graphic or an animated sequence, to edit the scene or to regress to an earlier point to change selections. I selected "edit scene" so that I could make additional modifications.

After selecting "edit scene," I clicked on "Backdrop" in the scene contents window. Elements in the scene contents win-



Catalog provides an excellent selection of predefined animation paths for giving model elements direction and motion. In addition to defaults, you can modify number of rotations, what portions of each model are affected by path, specify speed and other factors. These changes can be saved and added to user catalog section for reuse in future projects.



Compressor, color depth, animation duration and other options are all user-selectable from Generate Animation screen. Style selections include wireframes, solid models, realistic, realistic with shadows, ray traced and ray traced with shadows; so you can generate some very unique looks.

dow are automatically added or updated as you select or edit them. I selected the import graphic option from the modify backdrop screen, which was activated when I clicked on backdrop in the Scene Contents window. I browsed the selections available and decided to use a Targa graphics file of our 1933 Dodge coupe street rod as the backdrop for this scene.

Several picture options are available to help you fit the image into the scene as desired. The names of the selections describe what they do. They include center picture in scene, stretch picture to snapshot size, stretch picture proportionately, and a choice of white (the default) or a color of your choice for the border color.

For this project, I selected "stretch picture to snapshot size," since the original Targa graphic file was more rectangular than square. The program automatically re-scaled the image to precisely fit the scene rectangle. This is another of the nice automated touches the program provides that makes it a bit easier to fit square pegs into round holes.

At this point in the project, the backdrop (the picture of the Dodge coupe) is now in the scene, as is the SCREAMING MIMI text. By double-clicking on the compressed file of approximately 300K to 350K bytes in size. For one minute of final cut and edited video, two minutes of raw material are required. Depending on the quality of the video, this can require from 54M to 63M of disk space. If reasonable quality monaural sound is included with the video, an additional 22K is required to store the sound. If the sound is stored in stereo format, one second of audio requires 44K. These demands increase significantly as the desired quality level and frame rates escalate.

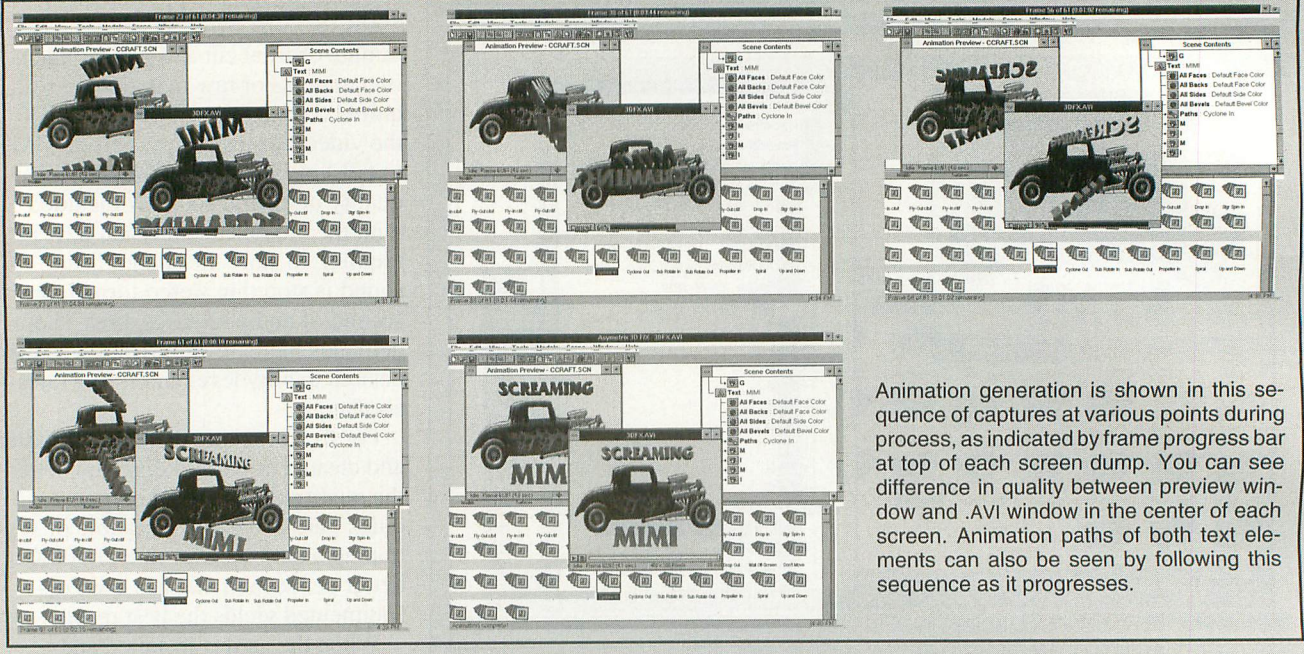
For the foregoing reasons, the faster and cleaner your hard disk, the better the quality of your final output. A quick hard drive that's capable of sustaining a data-transfer rate of 300K or better per second that has been defragmented yields the best results.

When the card is installed and you're confident in the speed of your hard drive, the next step is to install the video-editing software supplied with the card. The review DC1 unit I had came with *Adobe Premiere* as the bundled editing application, although it seems that it has also alternatively bundled U-Lead's *Video Studio* software with the card, since there are references to this package in the user's manual.

It's interesting to note that the Miro Video-XL compression driver should not be installed until the editing software is already on the system because the driver's applet functions as an extension of the editing package.

Adobe Premiere LE installs easily from the CD-ROM. Once this installation is completed, you're ready to install the Video-XL driver, which is accomplished from the Control Panel/Drivers applet in the Main group of *Windows*. Although *Windows* 3.1 is okay, Miro recommends using *Windows for Workgroups* 3.11 as the preferred environment.

Installing the driver consists of opening the drivers applet from the control panel in the Main *Windows* group, selecting "Add Unlisted or Updated Driver" and clicking on the "miroVIDEO DC1 MJPG Capture Driver" selection contained on the diskette supplied with the card. When the driver is installed, a hardware setup screen appears for you to select the I/O address range, interrupt and DMA channel for the card to use. Available



Animation generation is shown in this sequence of captures at various points during process, as indicated by frame progress bar at top of each screen dump. You can see difference in quality between preview window and .AVI window in the center of each screen. Animation paths of both text elements can also be seen by following this sequence as it progresses.

text, the text-editing window opens. I decided to make the two words each independent text models, rather than having them grouped together. By splitting the two words into individual entities, each one could have its own set of attributes, which include color, size, typeface, animation path and more.

I decided to go with 36-point Fritz Quadrata bold for the word "SCREAMING" and 60-point Fritz Quadrata bold for the word "MIMI". Since the car's color scheme is a deep metallic black cherry with hot red flames, I selected colors for the type that "worked" with this overall color scheme.

Other selections that affect how the model will appear are selectable from the Scene Contents window by clicking on the desired attribute. For example, clicking on the All Faces line permits you to select the frontal view (face) color for the text model, All Backs permits selecting the rear (back of the character) color, All Sides and All Bevels permit selecting those colors, respectively, as well. You can also modify the bevel of the text from available choices of none, angled, concave curve, convex curve, bevel size and thickness.

The catalog provides a splendid assortment of predefined animation paths that can be used to give motion and direction to the model element(s) in the scene. From this catalog page, I selected a fly-in from the center, bottom to the top front of the scene for the word SCREAMING. I then selected the "cyclone in" path for the word MIMI and defined four rotations for each selection.

The result of these selections produces the word SCREAMING rotating into the scene from a point out of view at the center-bottom to its final position at the center-top of the screen, while the cyclone effect produces the word MIMI entering the scene from an out-of-view position at the center-top of the screen, crossing the spiraling path of SCREAMING along the way, and finally coming to rest in its ending position at the center-bottom of the screen at precisely the same instant as the top word stops. The effect is simple to produce, yet quite dramatic to view.

You can preview how the animation will look by selecting this option from the Scene menu. Though the color rendering and animation won't be anywhere near as smooth as the finished project, it still provides an excellent visual reference in realtime of how the finished sequence will appear. I found it to be invaluable for posi- tioning the text elements and deciding on how many rotations of the elements would produce the effect I desired.

When all of the scene components and choices are as you want them to be, you're ready to actually generate the animated sequence. This is accomplished by selecting this choice, which also appears on the drop-down scene menu. You can accept all of the default values or select your preferences, as desired. Choice options include the appearance style of the rendered animation, the compressor, the size, color depth, smoothing, frame rate per second, total time for the sequence and other choices. Clicking on OK sets the generation process in motion.

The project I've described and illustrated here is a fairly uncomplicated and straightforward one that will give you the basic look and feel of the program, but by no means does it cover all of the possibilities, options and extra touches you can select. For example, you can click on the soundtrack option in the scene contents window and add a .WAV file to give your sequence an aural dimension. If you need to trim or extend the length of the audio segment to match the animation, the included WAVE edit utility is ideal for such purposes.

You can also change camera perspective from normal to wide angle or telephoto to obtain a different view of the animated elements. Additionally, you can select different lighting effects that include placement, ambiance, color, intensity and whether or not you want shadows to be cast. In trying to cover all of the major features of this robust program, I realize I've probably only scratched the surface, since each of the major choices seem to branch out into myriad subordinate options that yield what may well be an infinite number of combination possibilities.

Whether you want to create a slick 3D graphic as a company logo, produce an animated sequence to give your multimedia production or presentation some extra sizzle, or just explore the possibilities of what you can do with 3D and some imagination, Asymetrix's *3D F/X* is certainly a program that can and will do all of these things and more—at a price that makes it difficult to pass by!

Product Mentioned

Asymetrix 3D F/X on CD-ROM, $99.95
Asymetrix Corp.
110 110 Ave. NE, Ste. 700
Bellevue, WA 98004-5840
Tel.: 800-448-6543

CIRCLE NO. 190 ON FREE INFORMATION CARD

Miro's Video Mouse is an ideal companion to DC1 card because it gives full frame-accurate remote control of two VCRs. A number of different cables are provided, as is an infrared sensing unit, for controlling virtually every type of VCR available today, regardless of make or model.

Table 1. Technical Data for Miro DC1 Motion JPEG Capture/Playback Card

Component	Specifications
Bus	16-Bit AT Bus (ISA)
Memory	VRAM
Processor	LSI Single Chip JPEG Processor 64702
Decoder	Philips Video Decoder 7196
Encoder	Philips Video Encoder 7199
Power Supply	+5 Volts, 3.5 Amperes (Max.)/+12 Volts, 0.25 Amperes (Max.)
Video Inputs	1 X Composite-Video Input (Phono: 1.0 Vss)
	1 X S-Video input (Mini DIN; Y/C, 1.0 Vss/0.3 Vss)
	Inputs Selected By Software
Video Outputs	1 X Composite Video Output (Phono: 1.0 Vss)
	1 X S-Video Output (Mini DIN; Y/C, 1.0 Vss/0.3 Vss)
	Simultaneous Output To both Video Outputs
TV Standards	NTSC, PAL, SECAM
Video Scan Rate	14.75 MHz (NTSC 12.27)
Colors	16-Bit RGB, 24-Bit RGB
	Internal Color Representation Always 24-bit RGB
Settings	Brightness, Contrast, Saturation, Color (NTSC)
	Scaling
	Filters
	Capture Format, Capture Quality

Card supports good range of video formats and setting options, in addition to exporting digital video back to NTSC or S-Video device like a VCR.

choices are darkened, while those already in use or otherwise unavailable are grayed-out.

Reserved Memory Blocks

Since the DC1 uses a 16K video-memory area beginning with the video-memory range address specified in the hardware setup stage, it's necessary to exclude this memory area in the CONFIG.SYS and SYSTEM.INI files. For example, using the factory default memory range of CC00-CFFF, the appropriate entry in the CONFIG.SYS file would read: DEVICE=C:\WINDOWS\EMM386.EXE X=CC00-CFFF, and an additional line must be added to the [386Enh] section of the SYSTEM.INI file that reads: EMMExclude=CC00-CFFF.

The software does its best to suggest choices that won't conflict, but this isn't absolute gospel. So you'll do well to verify that these settings aren't being used by any other installed devices or applications. If the software doesn't successfully detect a conflict, crashes or system hang-ups will invariably result.

Having followed the installation instructions faithfully, including exclusion of the selected memory range, I was stumped when I methodically tried every available I/O range, video-memory range, interrupt and DMA channel and was still unsuccessful in getting the card to respond. I continually received an error message stating that "memory not readable at given address."

An entry in the troubleshooting appendix in the user's manual advised that it's also necessary to shadow the chosen memory range during DC1 installation in the PC's BIOS setup. Upon re-booting the system and invoking the BIOS screens, I shadowed the range of CC00 through CFFF, allowed the system to re-boot after saving the configuration change, re-launched *Windows* and—*voila!*—the card responded at this range.

Had this important information been included in the installation section of the manual, I would have saved myself a bit of grief and shaved about a half hour from what should have been an installation that took less than 15 minutes total time to accomplish. In retrospect, however, it

was better to have this information included in the troubleshooting appendix than not have it at all.

If you have another capture card installed in your computer (like Intel's Smart Video Recorder Pro, Digital Vision's ComputerEyes/1024 or any other), a dialog box that provides an option where you can select the default capture device you want to use will appear. Clicking on the box next to the miroVIDEO DC1 selection and following with a click on OK in the dialog box locks the DC1 card in as the capture device of choice until you manually deselect it at some future time.

Other Output Options

Using the DC1 with *Adobe Premiere* is identical to using the software application with any other video-capture card, except that you have some additional options, such as exporting the digital video production to videotape. With the card and driver correctly installed and configured, a special DC1 Display Utility applet that gives you the added capabilities becomes active on the *Windows* desktop when *Adobe Premiere* is launched. The Display Utility also becomes active and available whenever any valid video-capture program (Microsoft's VidCap, Asymetrix's *Digital Video Producer Capture*, etc.) is launched.

The Display Utility controls the DC1's video output. By default, Print to Video is selected. This option outputs video to the computer's video monitor through the PC's graphics adapter. Selecting print to video permits output of video to a VCR or TV receiver as an overlay on the computer's monitor.

A Loopthrough Video option box is also provided on the DC1 Display Utility screen that should be deselected when the DC1 isn't active, as when video sequences aren't being recorded or played back. The reason for this is that the VCR sends signals to the DC1, which then loops and returns the signals to the VCR, and so on. This is particularly true if you have the same VCR connected to the DC1's input and output. These signals have a tendency to amplify each other, which results in disturbing effects on the video monitor.

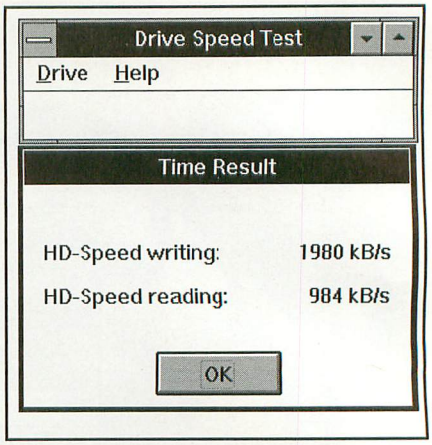
If you have a suitable graphics card installed in your PC, in addition to the DC1, an overlay control screen will also be available as an option that permits you to overlay computer graphics on top of video material for combined display or export.

Image-Quality Issues

The quality of the signal coming from your video input source is a key factor that directly affects the output quality of the video. To obtain the best quality possible, you should use an S-Video source, rather than a composite one. You can also achieve better video signal quality coming from a live video camera signal, as opposed to a videotaped signal. So, if possible, it's desirable to capture live sequences directly to disk using the DC1.

I advise you not to use videotapes that contain distortions or noise. As I mentioned above, each generation (successive copy) of a videotape contains more noise than the previous one, with a lowered signal strength.

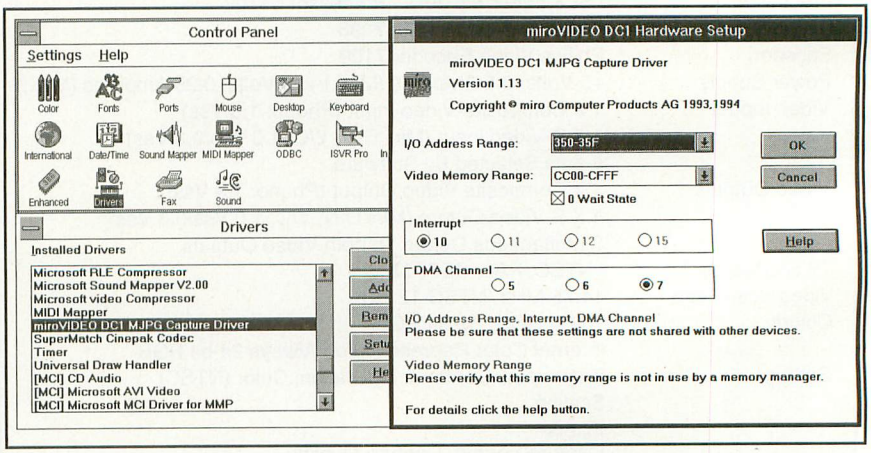
Some suggestions for obtaining optimal results with the DC1 are given in the manual. I've found them to be worthwhile for improving overall capture and playback quality. For example, each capture application requires different procedures to save digitized video sequences without dropping frames or other data loss. When using Adobe's *Video Capture*, the Capture Directly to Memory option is the preferred way to go. Conversely, best results are achieved with the Capture Directly to Disk option when using *VidCap*, and the File Save option is best to use with *Video Capture*.



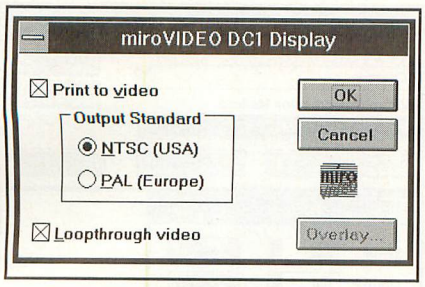
Miro includes HDSPEED.EXE program on DC1 driver disk to establish speed of a hard drive's data-transfer rate. Because data-transfer speed is so crucial to capturing and playing back video at acceptable rate, drive capable of minimum speed of 300K/s is required. As shown, IDE drive of this machine far exceeds minimum requirement.

Another useful tip regards cropping. When digitizing video images, it isn't necessary to digitize the entire image because the image margins don't contain relevant data. You can crop the margins without losing image information. When you crop an image, the amount of data is reduced and you can digitize at high quality without dropping frames.

As long as you see the image on the screen without black margins, you can increase the cropping factor without losing quality. Normally, a suitable cropping factor is between the two and four range. This can have a sub-



Miro video driver installs after software-editing application is already resident on system, since this driver looks for and depends on its presence to operate. Driver setup screen is shown, with all available choices darkened and unavailable options grayed-out.



DC1 display utility applet "travels" along with *Adobe Premiere*. It's active and available only when *Premiere* or another capture utility, like Microsoft's VidCap, is running. Accessing utility is accomplished using *Windows* task switcher or keying ALT-TAB to make it active window.

stantial effect on reducing the overall size of a file while increasing the quality settings.

Image quality depends on the filter, cropping factor and the way you capture video sequences. You can either capture at a fixed JPEG quality or at a fixed data rate. There are advantages and disadvantages to both schemes.

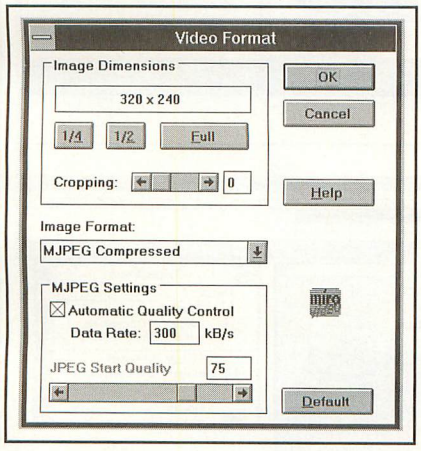
If you select JPEG Quality before capturing, image quality remains the same, but it isn't certain how much data is written to the hard disk. Each frame is captured at the specified quality. If your hard disk isn't fast enough to provide the quality you select, individual frames might be dropped.

If you plan to edit and cut video after capturing it, you should try to prevent frames from being dropped. However, if you plan to play back captured video on a computer (as opposed to exporting the video back to videotape), dropped frames aren't as much of a concern.

When you select the Automatic Quality Control option, you can specify the data rate you want to use. In this way, a defined constant amount of data is saved for each image. Depending on the amount of information the image contains, the quality of the image might be different for different images. In this operational mode, you can make use of a slider to set the desired JPEG Start Quality.

Since the slider can adjust itself only to a lower quality level, the JPEG Start Quality level you select is the maximum quality you can achieve. For this reason, you should always start with a higher JPEG Start Quality than the average quality that can be achieved in reality. By setting it higher than the default (usually 75), you have nothing to lose and everything to gain.

As with other capture devices, there are no general rules as to which capturing method is most-suitable for a given video sequence and specific computer platform. Experimentation with different settings to determine which one works best for you and yields best results is the order of the day, although you'll develop a feel for the best settings to use after a bit of practice.



Format of video capture can be adjusted and optimized in several ways, including image cropping, to reduce file size by discarding unnecessary and superfluous image data and by selecting either quality level or fixed data rate for captures.

MJPEG Display Quirks

A few caveats are unique to working with JPEG, as opposed to other compressors. When compressing with the JPEG algorithm, checkerboard patterns at sharp color transitions and edges (bright/dark) may appear, as can irregular color distribution instead of smooth color shades. Here's why:

JPEG image compression divides a video image into blocks of 8 X 8 bits for the Y information (or 8 X 16 bits for the UV information). The Discreet Cosine Transformation (DCT) converts each of these blocks (Y, U and V) into a frequency coefficient. After the DCT, sharp color transitions and edges have high-frequency portions. During quantization, data is reduced by displaying the high-frequency portions with less precision. The lower the JPEG quality, the less precise the high-frequency portions.

When the JPEG-compressed image is re-converted for analog output, imprecisions occur. The lower the selected JPEG quality, the greater the imprecisions. These imprecisions cause incorrect brightness and color information in analog images.

Because the re-conversion is also done on a block-by-block basis, incorrect information stops at the block borders, resulting in a flickering checkerboard-like image. I've found that this can be reduced and even eliminated in all but a few cases by increasing the JPEG quality setting.

Smooth color shades don't always turn out the way you expect with JPEG, either. The reason is that during quantization, data is also reduced by displaying the average brightness and color with less precision.

When re-converting a JPEG-compressed image, imprecisions also occur. In analog images, these imprecisions result in sharp color transitions in areas that had the same color and brightness or smooth shades before, resulting in blocks of different color shades.

Computer video monitors are especially sensitive to JPEG effects, although when recording video to a VCR these effects are partly eliminated. The manual recommends performing a complete digitizing, editing and recording procedure to check the quality of the VCR-recorded image, since this is really the only true way of knowing what the final recorded analog output will look like.

How JPEG Works

Describing what occurs when an incoming video stream is compressed using JPEG will aid in understanding why these things may occur.

A standard NTSC TV image displays at a resolution of 640 X 480 pixels, 24 bits of color depth and 30 frames per second. This format requires 25M of disk space for 1 second of video storage. Obviously, without video image data compression, storing long digital video sequences is prohibitive.

Software CODECS (COmpressor/DECompressor) compress image data without using the DC1 facilities. Software CODECS use the PC's CPU

and don't permit conversion of the digital video to the VHS format. Conversely, the DC1 utilizes its hardware-based JPEG compression to capture digital video sequences in VHS quality via its integrated JPEG processor.

The first step in JPEG data compression is image conversion from the RGB format (for example, a computer image that can be displayed on the PC's video monitor) into the YUV format. In this format, Y contains the brightness information (luminance), while U and V deliver the color information (chrominance).

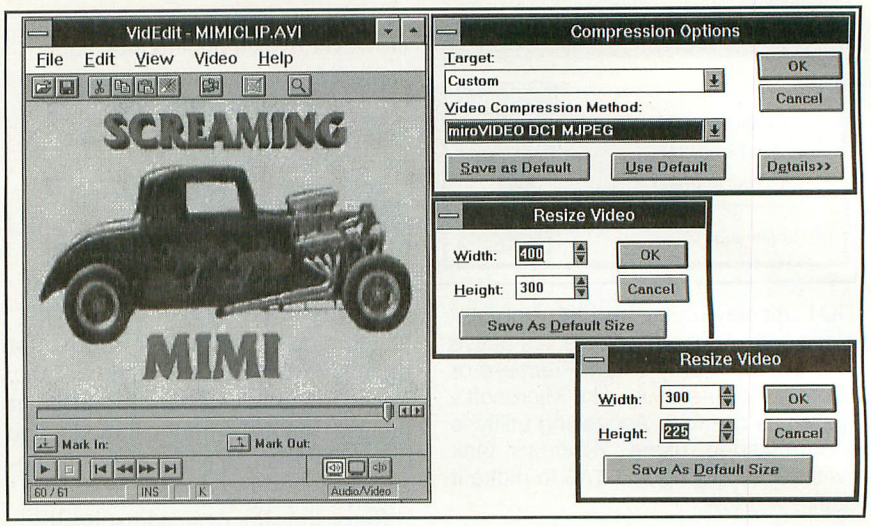
Because the human eye can discern differences in brightness better than differences in color, the chrominance sub-sampling method (reduced scanning of color information) can be used to capture video. The DC1 uses the 4:2:2 ratio in which there are four bits for brightness information and two bits for color information. The U and V color information is used only for every second pixel. A TV image delivers YUV signals so that no information is lost when digitizing video.

Every TV image delivers one brightness signal and two color signals per pixel. Discreet Cosine Transformation (DCT) converts these signals into a frequency coefficient that contains the color and brightness information. In this way, signals can be compressed more easily. Though DCT is the most computation-intensive step of JPEG data compression, its advantage is that it's lossless.

Quantization is performed by applying complex mathematical operations. This ensures that image parts that are important to the human eye are represented precisely. Irrelevant information is represented with less precision.

Run Length Encoding (RLE) makes use of the fact that many parts have a value of 0 after the DCT and that the quantization operation has been applied. Instead of saving all 0s individually, 0 is saved only once, together with a counter that indicates how often it occurs in succession.

The last step of JPEG image compression is the Huffman Coding method, which makes use of the statistical properties of the data being coded. This method evaluates how often and with what probability certain values occur. Values that occur seldom receive a long code, whereas those that occur frequently receive a short code.

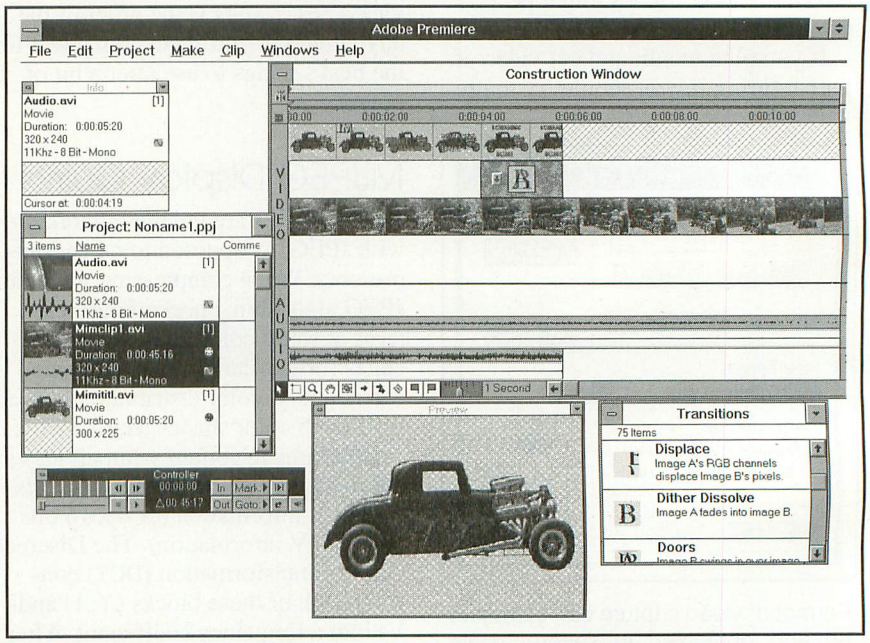


Before you can process animation or .AVI clip with DC1 card, it must first be re-compressed using miroVideo DC1 MJPEG compressor. This particular clip was originally created using Asymetrix *3D F/X* at 400 x 300 pixels image size and compressed using the Intel Indeo R3.2 algorithm. Using Microsoft's VidEdit, I changed the size to 300 x 225 pixels and re-compressed it with Miro compressor before importing into *Adobe Premiere*.

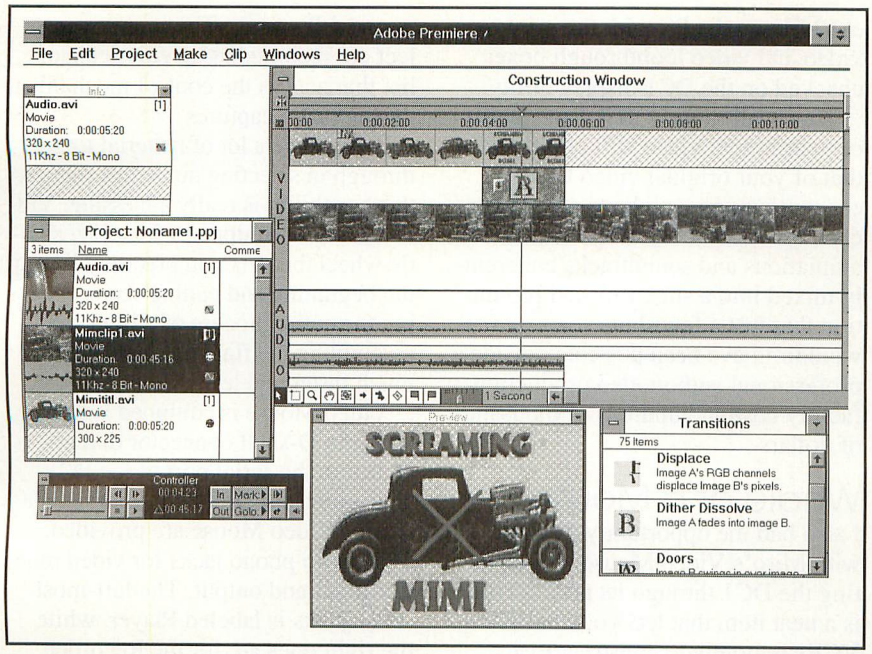
When playing back video, JPEG image compression steps occur in reverse order. Since the computer's CPU is free to attend to such chores as I/O, serving the software's requirements and all of the compression/decompression is being handled by the Philips video encoder and decoder on the DC1 card, realtime frame rates of 30 fps with quality at the level of VHS videotape becomes possible.

A Production Project

Using *Adobe Premiere*, I put together a small project featuring our 1933 Dodge street rod, *Screaming Mimi*,



All required elements are imported or captured into work area of *Adobe Premiere*. In this capture, MIMITITL.AVI clip was re-sized and re-compressed using VidEdit before it was imported. AUDIO.AVI and MIMICLIP1.AVI were both captured directly in *Premiere* using Miro DC1 as capture device with MJPEG compression algorithm. Preview of first frame of project is visible in preview window at bottom.



To save time during previews, actual generation of transitional effects is reserved for later when actual movie is "made." Transitions like dissolve, selected above, are represented by a red X through preview to indicate that transition will occur at this point in final generated sequence.

that illustrates all of the important aspects and capabilities of the DC1. The project consists of three clips: a title clip created using Asymetrix *3D F/X* (see "Easy 3D Effects For Less Than $100" box) the audio portion of another clip of the car with the motor revving and the main clip of my wife, Liz, driving Mimi down a country road.

The title animation clip was originally generated and saved using the Intel Indeo R3.2 compressor algorithm, and image size was 400 X 300. To make it compatible and to export it to videotape as part of the overall production, this clip had to be re-compressed using the Miro MJPG compressor. This was done by loading the clip into Microsoft's VidEdit utility and selecting the miroVideo DC1 MJPEG compressor. I also used VidEdit's resizing capability to change the image format size to 300 X 225 pixels, down from the original 400 X 300 format.

As I noted earlier, experimentation to achieve best results is crucial. I had originally re-sized this clip from 400 X 300 to the standard 320 X 240 image size. When I exported it to videotape, however, I found that the left and right edges of the image were being clipped, and the text at the top of the screen was also clipping slightly. Hence, through experimentation, I found that 300 X 225 pixels was the ideal size to use.

Assembling the individual components into the completed production proceeds as any other project using *Premiere*. Each clip is imported into the project work area. The elements are then dragged into the construction window and positioned as desired. You can also use portions of an element (like only the audio from a clip), if desired. This is a handy feature, since I wanted only the audio portion of the AUDIO.AVI file as a sound track for the silent opening-title animation sequence.

During assembly of the elements, you can choose from dozens of different transitional effects to smoothly transition from one scene into another. Some of these transitions (like dissolves and fades) can also be used with audio elements, as well as video or a combination of the two, and they can go in either direction. For example, in our example project, I selected Video A (the animated title sequence) to dissolve into main clip Video B. The direction could also be dissolved to go from Video B to Video A, if desired, by clicking on the arrow shown in the transition box between the Vid-

eo A and Video B tracks in the construction window.

You can continually change and rearrange the elements and transition effects, experiment with different mixes, etc., to your heart's content until you get everything the way you want it to be. When all is satisfactory, you select such options as the output image size, color depth and compressor, and you're ready to generate the movie by clicking on the Make Movie selection in the Make menu and giving the file a name. A status indicator let's you know how much time is remaining for generation to complete.

If you want to export the finished production to videotape, you must use the miroVideo MJPEG compressor. Otherwise, nothing will export. Recording the finished production to videotape is simply a matter of making a suitable cable connection between the DC1's video outputs (either composite video or S-Video, depending on your VCR's capability), and routing the audio from your sound card's line or speaker outputs to the VCR's audio input jacks. When these connections are made, you merely hit record on the VCR and play back the .AVI file on the PC with the print to video and video loopthrough boxes checked on the DC1 display utility.

This is all there is to it. The quality of your output video will closely rival that of your original video footage, except that now you have all of your cuts, transitions, titles, special effects, animations and soundtracks coherently mixed into a slick finished production that just a few short years ago wouldn't have been possible outside a professional audio/video production facility costing hundreds of thousands of dollars.

Whale of a Mouse

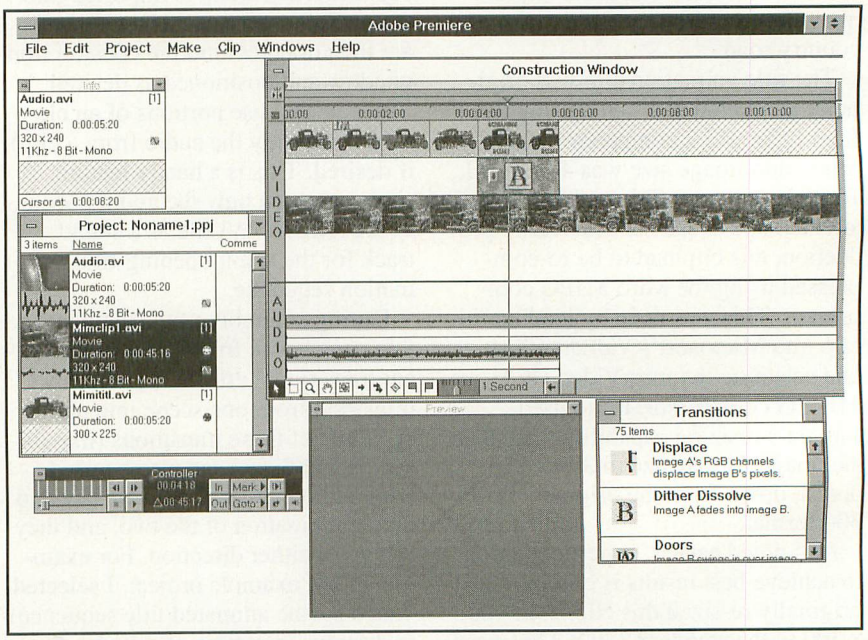
I also had the opportunity to work with Miro's Video Mouse while putting the DC1 through its paces. This is a neat item that lets you control two VCRs remotely to construct EDLs (edit decision lists).

While MJPEG compression does a good job of getting the most out of hard-disk space, it doesn't make sense to capture more scene data than you're actually going to use. With Video Mouse, you can select the starting and ending points of the scenes you want to capture, building lengthy lists of these scenes, if you so desire. Using *Adobe Premiere*'s Batch Capture facility, you can digitize them all in one fell swoop. The scenes you select are recorded as an edit decision list that acts as the control mechanism during batch captures.

If you have a lot of material to get through in selecting numerous scenes, this capability is really a blessing. Video Mouse is equipped with a jog/ shuttle wheel that lets you precisely line up the beginning and ending scenes, making the entire process of editing and assembling the final production a much faster and less tedious process.

Video Mouse is equipped with a nine-pin D-shell connector that attaches to the serial port of the PC. Two eight-pin DIN connectors at the rear of Video Mouse are provided, along with phono jacks for video monitor input and output. The left-most set of jacks is labeled Player, while the right ones are for the Recorder.

A light-touch keypad on Video Mouse permits you to select either the player or recorder deck and control the tape transport through buttons for play, rewind, fast forward, pause and stop. When you arrive at the desired scene, a larger green button is used to signify a cut-in or cut-out that will be added to the EDL. The jog/shuttle wheel on the mouse makes locating precise frame starting and ending points a snap.



When print-to-video and loopthrough-video boxes are checked in DC1 Display Utility, preview window is inactive on computer monitor, but you see preview on TV monitor connected to recording VCR deck. Preview window in this shot still displays red X to signify that transitional effect selected (dissolve) will be inserted during final movie generation at this point in production.

Products Mentioned

DC1 MJPEG Video-Capture Card With U-Lead *Video Studio,* $599; With Adobe *Premiere LE* + *Crystal Flying Fonts Pro,* $699
Video Mouse, $599
DC1 Pro Combo (DC1 Card, Video Mouse, Adobe *Premiere LE*), $1,195
Miro Computer Products, Inc.
955 Commercial St.
Palo Alto, CA 94303
Tel.: 415-855-0940
CIRCLE NO. 191 ON FREE INFORMATION CARD

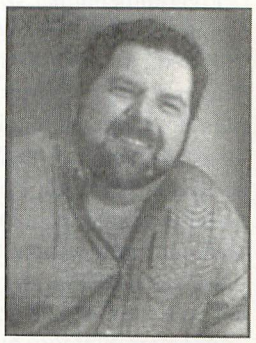
Introducing Desktop Video Book, $34.95 With CD-ROM
(Published by MIS:Press; autographed copies directly from author)
Tom Benford
2329 Hwy. 34, Ste. 201
Manasquan, NJ 08736
CIRCLE NO. 192 ON FREE INFORMATION CARD

Since Video Mouse carries a suggested retail price of $599 by itself, it's an accessory item that most users might tend to forego. However, if you're going to be doing lots of video production work, or even just analog videotape editing, it's an accessory item you'll be very happy to have on hand.

After using Video Mouse for a short while, you develop a real knack for tapping the function keys and shuttling to editing points in multiple scenes at speeds that wouldn't be possible without it. It's a device you can learn to love in a hurry, and it will spoil you to the point that you won't want to use manual VCR controls again.

As desktop video continues to mature and evolve, we're certain to see additional innovative products that will continue to "push the envelope" on what you can do with a PC to create professional-caliber video. But thanks to Miro's DC1 and Video Mouse, you don't have to wait for what the future may bring—you can have it all right now.

Photos by Joe Abbato/ The Photography Place



Tom Benford

By Duane M. Perkins

A PIC16C71 Development System

Part 3

Adding non-volatile RAM and a real-time clock

In the May/June 1995 issue of *MicroComputer Journal*, my "PIC16C71 Development System" article detailed how to build a pair of boards you can use to develop applications for the PIC16C71 microcontroller. Then in Part 2 in the July/August issue, I showed you how to add a keypad, LCD panel, UART and a buzzer to the basic system. In this third installment, I explain how to add non-volatile RAM and a real-time clock to the I/O Board.

Dallas Semiconductors' DS1994 Touch Memory makes this upgrade a snap. It contains 512 bytes of RAM, a real-time clock, an interval counter, a cycle counter and a lithium power cell. Like all members of the Touch Memory family, it's housed in a MicroCan that looks like the small mercury cells used in hand-held calculators. The button is about the size of a stack of three dimes.

I recommend that you call Touch Connections at 800-336-6933 or 214-778-6002 to request the DS9092K Touch Memory Starter Kit. For $75 plus shipping and handling, you get an assortment of Touch Memories, several accessories, a touch wand, a serial-port adapter, a bundle of software and well-written technical manuals. You need the wand, adapter and software to start and set the clock.

A Touch Memory button is electrically connected to a host by a ground connection to one face of the button and a signal connection to the other face. Data is transferred serially via the bidirectional signal path. An adapter is usually required to direct the host's TX and RX signals to/from the bidirectional path.

I/O-Board Upgrade

A simple interface is required to connect the DS1994 to the appropriate lines on the I/O Board, which is illustrated in Fig. 1. Diode *D2* must be a 1N34A germanium device simply because the voltage drop across a silicon diode is too great for this application.

The components for this upgrade mount in the spare pads located on the bottom center of the I/O Board. For purposes of this project, a standard mercury cell holder clip (included in the kit) will be used.

Figure 2 shows component placement and wiring on the underside of the I/O Board. Line A8 (RA3) at pin

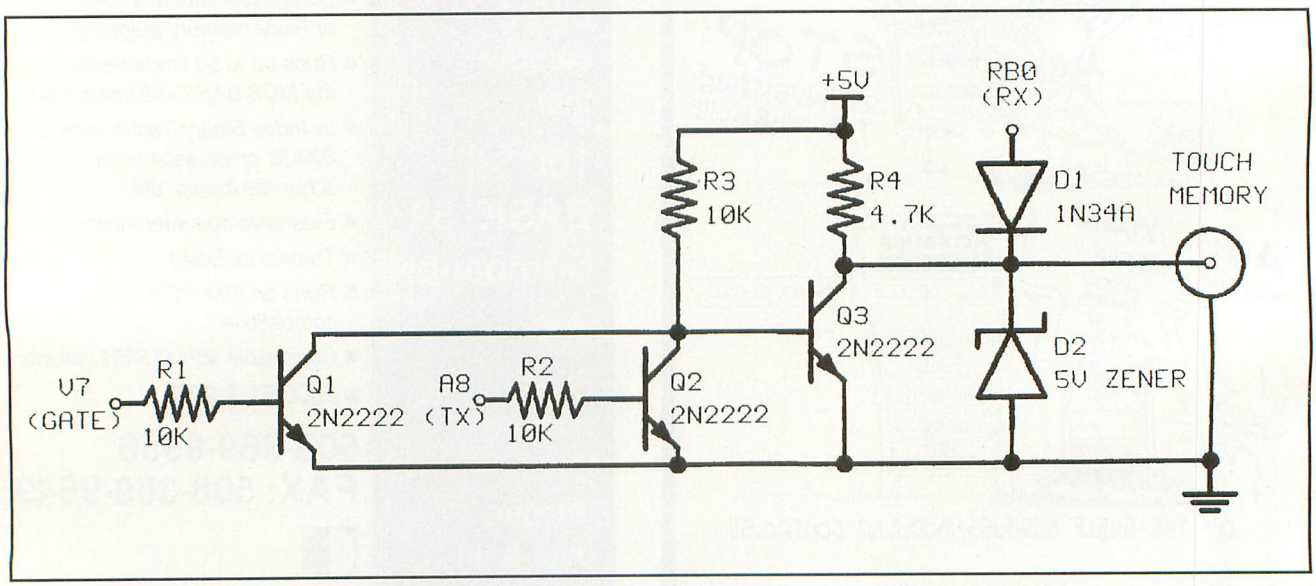


Fig. 1. Schematic details of the Touch Memory upgrade for the I/O Board.

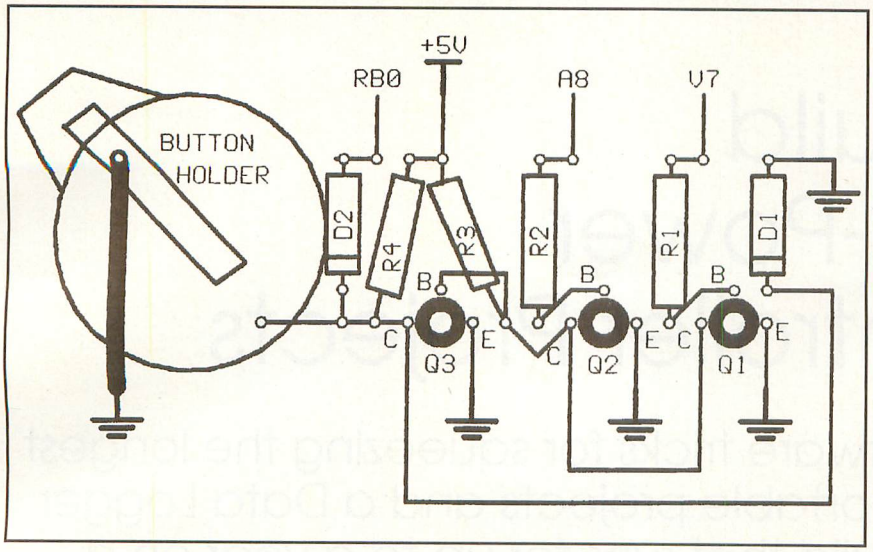


Fig. 2. Wiring guide for Touch Memory upgrade. Components mount on underside of I/O Board, as detailed in text.

21 of *J1* is used for TX and RB0 at pin 23 of *J1* is used for RX. Line V7 from pin 7 of *U2* is used to gate the interface circuit so that it's active only when address 7Xh is latched.

When address 7X is latched, V7 is low, switching off *Q1*. Therefore, RB0 follows the TX signal from A8. When TX is high, RB0 is high, unless the Touch Memory is pulling it low, which is what occurs when reading from the Touch Memory. Diode *D1* prevents RB0 from pulling the Touch Memory low.

Firmware

The program code required to read the Touch Memory and convert the time in seconds to year, month, day, hour, minute and second is in DATETIME.ASM, which is included in PIC71DEV.ZIP. You can download this file from the E D Technical Publications BBS by dialing 407-454-3198. Program a PIC from DATETIME.HEX with fuse options HS D D P and plug it into the ZIF socket.

When power is applied, the day, date and time will be displayed on the LCD. You now have a clock that doesn't have to be reset after every power failure. The DS1904s included in the Starter Kit don't have an active clock. Use the TOUCH program included in the demo software to enable the oscillator and set the clock.

Another program titled TOUCH_IO.ASM writes the first page (32 bytes) of RAM and then displays it on the LCD panel. The page is formatted as follows:

```
0       VLI     1Dh
1-29    ASCII   ABCDE-
FGHIJKLMNOPQRSTUVWXYZ789
30-31   CRC     3384h
```

The display should be as follows:

```
1Dh  ABCEDFGHIJKLMNOPQRSTU-
VWXYZ789
3384h
```

The technical manuals included in the Starter Kit provide all the information you need to enable you to develop your own programs. You can use other types of Touch Memory in place of the DS1994. Potential applications are as limited as your imagination. ■

Need Help?

If you have a problem you can't resolve or need any technical help, feel free to call me during Eastern daytime hours at 717-964-3536. Send me a floppy disk of your choice if you want a copy of the program files. Address your request to:

Duane M. Perkins
PO Box 255
Mt. Gretna, PA 17064

By Philip Doucet & Robert Grappel

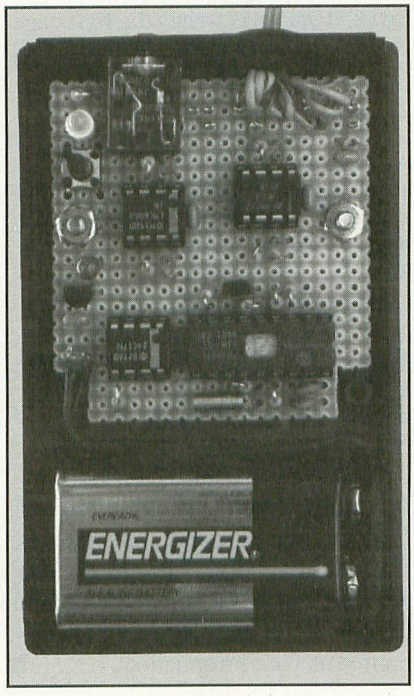
How to Build Ultra-Low-Power Microcontroller Projects

Hardware and software tricks for squeezing the longest possible life from portable projects and a Data Logger project you can build that runs for up to a year on a single 9-volt battery

If you want to build portability into your next microcontroller-based project and wish to obtain maximum lifetime from its battery, we offer here a simple ultra-low-power solution in the form of a Data Logger that runs for months on a single battery. We discuss both hardware and software tricks of the trade for achieving low-power operation and describe what to look for in operational amplifiers and voltage regulators and other components you'll want to consider for any battery-powered circuit. Use of an EEPROM for maintaining circuit and sensor calibration data is detailed as well.

In this article, we detail many of the features of the popular Microchip series of PIC microcontrollers, with hints for using the real-time clock/counter, I/O interrupts, on-chip A/D converter and other PIC features. To wrap up, we provide you with the complete software for effecting serial communication to serve as an example of the unique challenges in programming a low-power application.

To keep this discussion hands-on, we present an ultra-low-power Data Logger you can build with only four ICs and a few miscellaneous parts (an assembled version is also available per the Note at the end of the Parts List). The "Data Logger Features" box lists the capabilities of this project. To finish the project, you'll add some temperature transducers.



Ultra-Low-Power Design Criteria

The Data Logger is excellent for keeping track of the temperatures. It consumes about 75 µA of current while *operating*—not stopped or in any kind of idle state. This minuscule drain is actually while running code, keeping time and periodically logging two temperature readings to an EEPROM. At this rate of current drain, one battery can power the Data Logger for almost a year.

Any low-power design should use the following three techniques: (1) selection of low-power components; (2) turning off things when they're not in use; and (3) utilizing low-power processor operating modes. We'll describe the Data Logger from these perspectives and then discuss the software needed to run it and how you can build the Data Logger. Refer to the complete Data Logger schematic diagram shown in Fig. 1 throughout the following discussion.

• **Low-Power Components.** Though it's obvious that the simplest way to reduce power consumption is to select components that consume very little power, this isn't necessarily easy to do. Manufacturers usually advertise speed and features but not power consumption. Distributor catalogs don't list power-consumption information, nor do most IC directories.

Keep in mind that popular devices are rarely suitable for low-power design. For example, when you need a 5-volt regulator, it's tempting to just grab a 78L05, thinking that the "L" stands for low power. In reality, the "L" means low output power, not low power consumption. The quiescent current for the 78L05, which is the amount of current it needs just to operate its own internal circuits *not* including the load current of your circuit, is about 3 mA, enough to exhaust most batteries in about a week.

After combing through dozens of

Data Logger Features

jThe Data Logger described in the main article offers many features. In addition to logging up to 2,000 values, with its simple command set and RS-232 interface, it can also serve as a data-acquisition device for your PC. You can use virtually any transducer that outputs a voltage to measure temperature, relative humidity, pressure, displacement, light level, etc. Logging interval settings range from once per second to once per day. Other features include:

- Four channels
- Eight bits of resolution
- Eight to 12 months of continuous operation from standard 9-volt alkaline battery
- A status light that indicates proper logging operation
- A pushbutton switch that starts logging
- A minimum/maximum recording mode

In addition, PC software is available to turn the Data Logger into a useful tool for hobbyist or professional use. It requires only a minimal PC with serial interface, DOS 3.3 or later, 256K of RAM, an EGA or VGA display and a mouse. An easy-to-use pull-down menu format is employed for operating the Data Logger and plotting results. Other features of the software include:

- Plots of one to four channels on PC's display or printer
- Saving logs to disk
- Plots that can be expanded or compressed
- Data available in ASCII format for use with other programs like a database, spreadsheet, etc.)
- Selectable gain and offset for each channel ±0 to 128)

manufacturers' data books, we've determined that the following devices are excellent choices for ultra-low-power applications. They're readily available and low in cost, and they provide very good overall performance. Other manufacturers have competitive products that might better suit your particular application, though the same selection and circuit-design techniques presented here will be applicable. Addresses and telephone numbers for the manufacturers mentioned here are given at the end of the Parts List.

Now let's look at the various low-power devices that are used in the Data Logger.

Microcontroller. Microchip's extremely popular PIC series is most noted for its high-speed operation and efficient architecture and relatively easy-to-learn instruction set. Less well-known are some of its excellent low-power characteristics, such as a typical power-supply current of about 60 µA at a clock frequency of 32 kHz.

All CMOS devices, the PIC included, can run at very low clock frequencies to obtain very low power consumption. One of the PIC's advantages over other microcontrollers is an efficient instruction set that makes it possible to do useful work while running at extremely slow speeds.

Many portable devices must measure temperature, humidity, barometric pressure, sound level or some other analog variable. A microcontroller with a built-in A/D converter eliminates the need for a separate A/D chip and the software required to operate it. PIC16C71 *U2* in Fig. 1 has an eight-bit A/D converter with a four-channel multiplexer that you can measure four different variables. It also has on-chip a variety of handy features, like a power-on reset circuit, a real-time clock counter, four interrupt sources and a watchdog timer. You'll be using everything except the watchdog timer in the Data Logger, which will give you a very good feel for the capabilities of this microcontroller.

Bear in mind that in applications like portable PCs that may need processing horsepower, reduction of clock speed may not be a wise design decision. Although the processor draws less power, it may have to run for a longer time to complete a given task. In such a case, total energy consumed may not be any less than when running at a faster clock.

Batteries store energy, and energy = power x time. If you reduce power but increase the time during which it's consumed, the battery may not notice the difference. Since the Data Logger must run continuously to keep time, this isn't an issue.

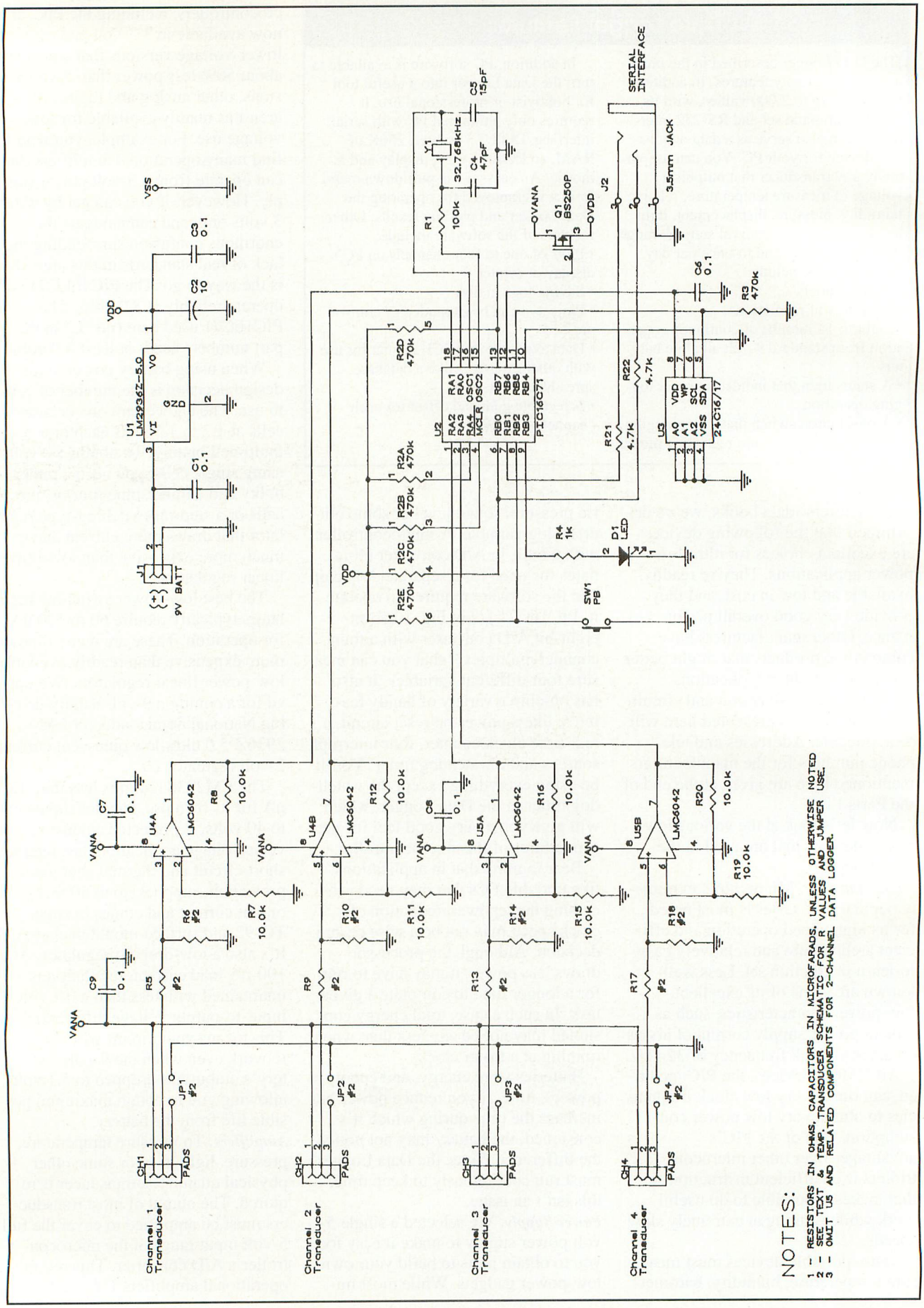
Power Supply. We selected a single 5-volt power supply to make it easy for you to obtain parts to build your own low-power gadgets. While most microcontrollers, including the PIC, are now available in 3.3-volt and even lower-voltage versions that consume about 50% less power than 5-volt versions, other analog and digital ICs aren't as readily available for low-voltage use. For example, you won't find many operational amplifiers that can operate from a 3-volt power supply. However, if you can get by with 3 volts only and can navigate the enormous confusion surrounding the lack of real standards in this area, this is the way to go. The PIC16LC71 will operate reliably at 3.0 volts. The PIC16C71 used here (no "L" in the part number) needs at least 4.0 volts.

When using battery power, a major design decision is the number of cells to use. The choices are one or more cells at 1.2 to 1.5 volts each or a multi-cell battery. To obtain 5.0 volts using single cells, you need a rather bulky and cumbersome four or five cells or a step-up switching-type regulator that draws more current and is much more expensive than low-power linear regulators.

The best low-power switching regulators typically require 60 to 120 µA for operation. These are many times more expensive than readily available low-power linear regulators. We opted for a common 9-volt battery driving National Semiconductor LM-2936Z-5.0 ultra-low quiescent current 5-volt regulator *U1*.

The LM2936 requires less than 15 µA for its own use, handles inputs up to 40 volts, is protected against reverse voltage application, has internal short-circuit and thermal shutdown protection, supplies up to 50 mA of output current and comes in small TO-92 and surface-mount packages. It's also a low-dropout regulator. At a 100-µA load current, regulation is maintained with less than a 0.1 volt input-to-output voltage differential. This means your circuit will continue to work even when the 9-volt battery's output has dropped to 5.1 volts, allowing you to obtain maximum possible life from the battery.

Amplifiers. To measure temperature, pressure, light level or some other physical quantity, a transducer is required. The output of most transducers must be amplified to cover the full 5-volt input range of the microcontroller's A/D converter. This requires operational amplifiers *U4* and *U5*.


NOTES:
1 - RESISTORS IN OHMS, CAPACITORS IN MICROFARADS, UNLESS OTHERWISE NOTED
2 - SEE TEXT & TEMP. TRANSDUCER SCHEMATIC FOR R VALUES AND JUMPER USE.
3 - OMIT U5 AND RELATED COMPONENTS FOR 2-CHANNEL DATA LOGGER.
Channel 1 Transducer
Channel 2 Transducer
Channel 3 Transducer
Channel 4 Transducer
PADS
LMC6042
PIC16C71
24C16/17
LM2936Z-5.0
9V BATT
SERIAL INTERFACE
3.5mm JACK
BS250P
32.768kHz
VDD
VSS
VANA

PARTS LIST

Data Logger

Semiconductors

D1—Green 2-mA light-emitting diode in T-1 case
Q1—BS250P, p-channel small-signal 45-volt, 200-mA MOSFET in TO-92 case
U1—LM2936Z-5.0, 5-volt micro-power LDO voltage regulator in TO-92 case (National Semiconductor)
U2—PIC16C71-04/P 5-volt, 4-MHz OTP microcontroller with four-channel A/D converter in 18-pin DIP (Microchip)
U3—24C16, 16K-bit IIC serial EEPROM in eight-pin DIP
U4,U5—LMC6042IN dual operational amplifier with 5-volt micro-power rail-to-rail output (National Semiconductor)

Capacitors

C1,C3,C6 thru C9—0.1-µF, 50-volt, 20% tolerance radial-lead Z5U monolithic ceramic
C2—10-µF, 6.3-volt, 20% tolerance radial-lead tantalum
C4—47-pF, 50-volt, 5% tolerance radial-lead NP0(COG) ceramic
C5—15-pF, 50-volt, 5% tolerance radial-lead NP0(COG) ceramic

Resistors (1/4-watt, 5% tolerance)

R1—100,000 ohms carbon-film
R3—470,000 ohms carbon-film
R4—1,000 ohms carbon-film
R5,R6,R9,R10,R13,R14,R17,R18—See text
R21,R22—4,700 ohms carbon-film
R2—470,000-ohm x 5 resistor bussed SIP resistor network
R7,R8,R11,R12,R15,R16,R19,R20—10,000 ohms 1% metal-film

Miscellaneous

J1—9-volt battery snap cable with 6" leads
J2—3.5-mm stereo phone jack with pc-right-angle mount (*Mouser No. 161-3501)
JP1 thru JP4—Jumper (see text)
SW1—Momentary-action spst pc-mount pushbutton switch, (*Mouser No. 101-0011)
Y1—32.768 kHz watch crystal
Printed-circuit board; 3 3/4" x 2 1/4" x 1" enclosure with 9-volt battery compartment (Radio Shack No. 270-293); temperature transducers (see text); machine hardware; hookup wire; solder; etc.

PC Serial Interface

Semiconductors

U1—MAX232CPE, 5-volt RS-232 transceiver
U2—LM2936Z-5.0, 5-volt regulator (National Semiconductor)

Capacitors

C1 thru C4—1-µF, 16-volt radial-lead tantalum
C5—10-µF, 6.3-volt radial-lead tantalum
C6—0.1-µF, 50-volt radial-lead Z5U monolithic ceramic

Miscellaneous

P1—25-position subminiature D-shell female connector with crimp-type sockets
P2—3.5-mm stereo phone plug cable (*Mouser No. 172-2206)
Enclosure—Subminiature D-shell plastic hood (Radio Shack Cat. No. 276-1520)

Note: The following items are available from PR Designs Inc, 48 Cutler Rd., Andover MA 01810-3427, tel.: 508-470-0498 (9 A.M. to 5 P.M. EST): programmed PIC16C71-04/P, $19.95; both pc boards (no parts), $19.95; complete software (PIC source code plus DOS-compatible PC software for operation and plotting) on your choice of 5 1/4" or 3 1/2" diskette, $29.95. Also available is a completely assembled Data Logger (no transducers) and serial interface, both with enclosures, for $99.95. Temperature transducers with 3-ft. cables are $9.95 each (specify 0° to 212° F or –40° to 185° F range desired) and are installed in the Data Logger at no additional charge if ordered with an assembled unit (call or write if you have other require ments). All prices include postage and handling. Massachusetts residents, please add 5% sales tax.

*For exact fit on PC board, use suggested parts from Mouser Electronics (tel.: 1-800-346-6873). Many other parts are also available from Mouser and Digi-Key (tel.: 1-800-344-4539).

Manufacturers Mentioned

Analog Devices
One Technology Way
Norwood, MA 02062
Tel: 617-329-4700
CIRCLE NO. 226 ON FREE INFORMATION CARD

Maxim Integrated Products
120 San Gabriel Dr
Sunnyvale, CA 94086
Tel: 408-737-7600
CIRCLE NO. 227 ON FREE INFORMATION CARD

Microchip Technology Inc
2355 W. Chandler Blvd.
Chandler, AZ 85224
Tel: 602-963-7373
CIRCLE NO. 228 ON FREE INFORMATION CARD

National Semiconductor
2900 Semiconductor Dr.
Santa Clara, CA 95052
Tel: 800-272-9959
CIRCLE NO. 229 ON FREE INFORMATION CARD

Current consumption is of only moderate concern here because you'll be turning on and off *U4* and *U5* to make measurements. A much more critical concern is the ability of the op amp to swing its output over the full 0-to-5-volt supply range.

Since most op amps won't do this, a bit of headroom is required to operate internal drive circuits. Some swing fully to just one side or the other (ground or supply). You need a "rail-to-rail output" ability.

An exceptionally low power consumption device to use here is the National Semiconductor LMC6042. Since this micro-power device uses only 10 µA per amplifier, it can be left on continuously without appreciably draining a battery. For even lower power consumption, at about triple the cost of the LMC6042, take a look at Maxim's rail-to-rail output 406/407/409 series that consumes only 1.2 µA per amplifier!

In addition to considering the output voltage range of the amplifier, don't overlook the issue of input voltage range. The input common-mode voltage range (CMR) of an op amp specifies the minimum and maximum voltages at the actual + and – signal input terminals for which the op amp will function properly. For the LMC-6042, CMR is 0 to the positive supply value minus 2.4 volts. Some amplifiers won't handle inputs near ground potential (0 volt) very well.

The high end of the LMC6042 limits its input signals to 5 – 2.4, or 2.6 volts. If you want to measure greater voltages, you must first attenuate them so that the input is never more than 2.6 volts. A few available op amps feature "rail-to-rail" inputs that don't have this restriction. However, they aren't usually low-power devices. To remain within the input range of the LMC6042, each op amp has a gain of 2. So a full-scale input signal of 2.5 volts provides a full-scale 5-volt signal to the A/D converter input.

The LMC6042 is a dual op amp. The same low-power technology is also available as a single op amp in the LMC6041 and a quad op amp in

← **Fig. 1.** Complete schematic diagram of Data Logger circuit.

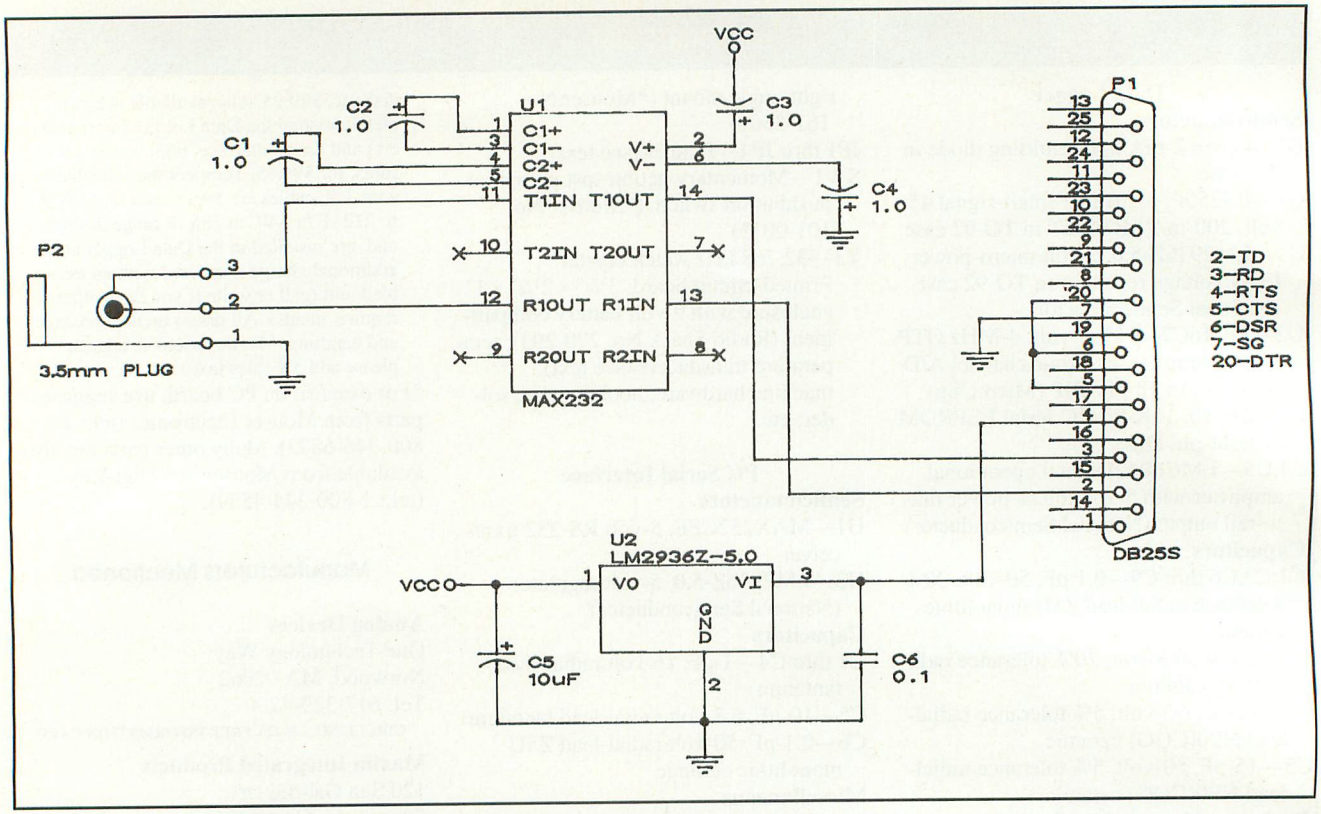


Fig. 2. Schematic diagram of Data Logger's serial interface circuit.

the LMC6044. We chose a dual op amp so that if you need only a one- or two-channel Data Logger, you can omit *U5* to save a few dollars and a few microamperes.

The temperature transducers you need for your Data Logger should be relatively low-power devices, although, like the amplifiers, you'll turn them on only to make measurements. There are a variety of devices that measure temperature (see "Temperature Transducers" box).

In rare cases, you may have to use a transducer that requires a warm-up period and can't be turned on and off to make measurements. In such a case, power consumption will be a critical issue.

EEPROM. Finally, your Data Logger must have memory. To be on the safe side, in case the battery ever runs down prematurely, you'll use non-volatile memory in the form of an EEPROM. We'll also show you how EEPROMs are frequently used to store calibration data.

Small and low-cost serial interface EEPROMs that contain 1K to 16K bits of storage (256 to 2K bytes) are popular in everything from kitchen appliances to automobiles. Numerous companies manufacture a wide variety of these, which are basically compatible though some have unique "write-protect" and segmentation features. These EEPROMs communicate via a special serial interface, and there are three popular standards in use: Inter-Integrated Circuit (called IIC or I²C by Philips/Signetics), Microwire (by National Semiconductor) and Serial Peripheral Interface (SPI by Motorola). The principal differences are the number of wires needed to interface and access speed.

Microwire and SPI devices can typically be clocked at speeds five times faster than I²C devices. However, access speed isn't a concern in this application, but the limited number of I/O lines on the microcontroller certainly is. Since I²C requires two wires, while the others need three or four wires, we chose an I²C-compatible 24C16 for *U3* that stores 16K bits (2K bytes) of data.

The second-best way to save power is to turn off anything in the circuit that isn't being used. For example, power need not be supplied to transducers when no measurements are being taken or to memory when it's not being accessed. This is the technique found in all portable computers that selectively shut down disk drives, peripherals, the display and even portions of main memory when they're not being used.

There are several ways to power down facilities that aren't being used, depending on how much current is required by the device to be controlled. The main choice is the type of device to use for switching.

Since electromechanical relay coils use far too much power, transistor switches are much preferred. At currents greater than 1 ampere, n-channel MOSFETs are the usual choice because their on resistance is lower than equivalent p-channel units. This results in minimal voltage drop and power loss. However, a voltage greater than the supply is needed to drive them, which usually dictates use of a FET driver IC. Fortunately, you need only small currents and use p-channel MOSFET *Q1* driven directly by the microcontroller.

MOSFET *Q1* switches power to the Data Logger's transducers and amplifiers. This circuitry needs power only when making a measurement and can be turned off when not in use to save a considerable amount of power. The

lowest-power temperature transducers (National LM34/35 series) consume 60 µA each and the amplifiers 10 µA each, for a total of 280 µA for four channels. This is four times as much current drain as the rest of the Data Logger. If these circuits were left running continuously, battery life would be cut by 80%!

When selecting transducers to use with the Data Logger, make sure they don't require a warm-up period. They must also be able to provide a stable output within 1 ms after power is applied because the Data Logger waits only this long from turning on power to taking a reading (you can modify the software to provide a longer delay).

For switching very-low-power loads, you can even use the microcontroller's I/O lines themselves, turning them on and off to power external loads of a few milliamperes. The PIC16C71 has greater I/O drive capability than most microcontrollers, but be aware that output voltage falls dramatically with increasing current, to about 3 volts at 20 mA when supplying current. You can obtain slightly better results if you use the I/O line as a switch to ground.

The Data Logger uses processor output RB6 to supply power to the EEPROM. When a memory read or write operation is to be done, the output is turned on (set = 1). It's then turned off (set = 0) when the read or write cycle is done. This saves about 60 µA, which is the quiescent current used by the EEPROM when data is neither being written nor read.

Listing 1. Interrupt-Driven Received-Data Routine

```
;
;
; ***************      INTERRUPT HANDLER***************
;
;
                org     IRQ_VEC
                movwf   W_temp          ; save W
                swapf   STATUS,W
                movwf   stat_temp       ; save STATUS
                btfss   INTCON,INTF     ; is this an INT interrupt?
                goto    int_ret         ;    no - ignore it
;
; INT pin (serial comm interface received data) interrupt handler
;
                bcf     STATUS,C
;
; with a 4 cycle interrupt latency, we've used 10 cycles to
; get to here, and are ready to start sampling first data bit
;
; receive loop must total 7 cycles for each data bit
;
rcv_loop        btfsc   PORTB,RD        ; loop to receive data bits
                bsf     STATUS,C        ; LSB first
                rrf     sci_data
                bcf     STATUS,C
                decfsz  bit_count,same
                goto    rcv_loop
;
; set recv'd data flag, reset bit_count, clear INT flag, and return
;
                bsf     m_flags,rdf
                movlw   08h
                movwf   bit_count
                bcf     INTCON,INTF     ; reset INT flag
int_ret         swapf   stat_temp,W
                movwf   STATUS          ; restore STATUS
                swapf   W_temp,same     ; restore W (swapf instruction
                swapf   W_temp,W        ;   does not affect STATUS)
                retfie
```

• Processor Operating Modes. You may have heard about the efforts to reduce power consumption of advanced microprocessors like Intel's original Pentium chips because the 5-volt versions get so hot. An increasingly popular solution is to apply power management, as described above, to various parts of the circuit on a single IC chip. For example, a processor may turn off its math coprocessor when it's not being used. As soon as a floating-point math instruction is detected, the coprocessor is started up to handle it and then turned off when it's done.

While the Data Logger certainly doesn't have a heat problem, the 60-µA draw of the PIC16C71 doesn't include its on-chip A/D converter, which consumes a comparatively whopping 180 µA! Fortunately, the PIC provides a means to turn on and off the A/D converter via bit ADON in an A/D control register. Power is conserved by turning on the converter, making a couple measurements and then turning it off again. The A/D converter is quite fast, performing an eight-bit conversion in about 6 µs. Averaged out over the full minute, the "spike" of power consumption becomes negligible, since the converter will be off for almost the full minute.

In certain applications, you may be able to use the PIC in its low-power "sleep" mode, during which program execution is stopped. This mode consumes less than 1 µA. However, since we wanted to use the 32-kHz crystal to let the processor keep accurate track of time, its program must run continuously.

Additional power savings could alternatively be achieved by using an ultra-low-power time-keeping chip with its own crystal clock to wake up a sleeping PIC only when it's time to make measurements. However, we were already at such low power levels that we chose to avoid the added complexity and cost of an extra IC and crystal that would be needed to accomplish this.

The last issue regarding processor power consumption is driving the processor clock. The clock drive circuits have to deal with the slow-changing sine-wave shaped voltage levels of an oscillator and can draw as much current as the rest of the processor with its very efficient CMOS logic

circuits. To address a variety of clock drive requirements, the PIC offers four programmable clock driver modes. These are: low power (LP), crystal (XT), high-speed (HS) and resistor/capacitor (RC).

RC mode is for timing only non-sensitive applications and isn't very accurate. XT and HS modes use a ceramic resonator or crystal at fairly high power levels. The 32-kHz watch-type crystal lets you use low-power mode.

Since current consumption depends upon the crystal and mode selected, Microchip doesn't specify total PIC power consumption with the clock driver included. In addition, crystals other than the exact device given in the Parts List may require slightly different values for *R1*, *C4* and *C5* to ensure reliable operation and lowest power consumption. The 60-µA figure mentioned above as PIC operating current is based solely on our own experience with many 16C71s and obviously can't be guaranteed by Microchip, since it depends so much on the external oscillator components. We discovered that about half of the 60 µA is for the oscillator, with the remainder for the PIC itself.

A real "gotcha" involving the windowed version of the PIC16C71 is that leaving the window exposed increases current consumption by almost 10 µA. Therefore, always be sure to cover the window with an opaque label or tape.

Listing 2. Transmitted-Data Routine

```
;
; ***************      SCI_XMIT      ***************
;
; sci_xmit sends W out serial port in N,8,1 (no parity,
; 8 data bits, one stop bit) format at 1200 baud
;
sci_xmit        movwf sci_data
                movlw 8h
                movwf bit_count         ; reset bit counter
                bcf   STATUS,C
                movf  PORTB,W
                movwf B_Temp            ; copy current PORTB to B_Temp
;
; each bit must be 7 cycles long
;
strt_bit        bcf   PORTB,TD
bit_0           rrf   sci_data
                btfsc STATUS,C
                bsf   B_Temp,TD
                btfss STATUS,C
                bcf   B_Temp,TD
                movf  B_Temp,W
                movwf PORTB
bit_1           rrf   sci_data
                btfsc STATUS,C
                bsf   B_Temp,TD
                btfss STATUS,C
                bcf   B_Temp,TD
                movf  B_Temp,W
                movwf PORTB
bit_2           rrf   sci_data
                btfsc STATUS,C
                bsf   B_Temp,TD
                btfss STATUS,C
                bcf   B_Temp,TD
                movf  B_Temp,W
                movwf PORTB
bit_3           rrf   sci_data
                btfsc STATUS,C
```

Complete Data Logger Circuit

There's little in the Data Logger circuit that hasn't already been described. One is the issue of how to communicate with the Data Logger. The obvious choice is a serial interface connected to a PC. This entails RS-232 voltage levels, which necessitates use of a suitable interface chip that converts the microcontroller's 5-volt signal levels to the required ±10-volt or so levels.

A device like Maxim's MAX242 is a good low-power choice here because it has a shutdown mode that draws less than 10 µA. However, it's more than double the cost of regular interface devices that draw a significant 5 mA and is somewhat difficult to locate in single-unit quantity.

Since there's no communication with the Data Logger, except to perform setup and dump the collected data, there's no need to make the interface a permanent part of the circuit. Thus, we decided to make the interface part of the connecting cable to the PC.

The simple RS-232 interface circuitry shown in Fig. 2 can be built to fit inside a large DB-25 shell (the type used for making null modem cables has lots of room) and can be powered from the RS-232 RTS line using an LM2936 regulator. Once you have this cable, you can use it to interface with lots of different projects that have 5-volt CMOS-level serial communication and must communicate at RS-232 levels.

Never leave the serial interface plugged into the Data Logger unless it's being used. When the PC's RTS signal is turned off, the interface is no longer powered and can draw several hundred microamperes from the Data Logger itself. This will drain the battery much faster than expected.

You'll notice a number of 470,000-ohm resistors tied to certain I/O lines of *U2* in Fig. 1. CMOS inputs are very high impedance and, thus, are susceptible to noise pickup, which increases power consumption. Therefore, any microcontroller I/O used as an input must have a pull-up or pull-down resistor to prevent this. Although it's always an output, the RB7 line used to drive *Q1* also has a pull-up resistor to guarantee that the analog circuits are turned off during processor start-up before the software has a chance to properly set the I/O line.

Finally, low-power LED *D1*, under software control, flashes once every

```
                bsf     B_Temp,TD
                btfss   STATUS,C
                bcf     B_Temp,TD
                movf    B_Temp,W
                movwf   PORTB
bit_4           rrf     sci_data
                btfsc   STATUS,C
                bsf     B_Temp,TD
                btfss   STATUS,C
                bcf     B_Temp,TD
                movf    B_Temp,W
                movwf   PORTB
bit_5           rrf     sci_data
                btfsc   STATUS,C
                bsf     B_Temp,TD
                btfss   STATUS,C
                bcf     B_Temp,TD
                movf    B_Temp,W
                movwf   PORTB
bit_6           rrf     sci_data
                btfsc   STATUS,C
                bsf     B_Temp,TD
                btfss   STATUS,C
                bcf     B_Temp,TD
                movf    B_Temp,W
                movwf   PORTB
bit_7           rrf     sci_data
                btfsc   STATUS,C
                bsf     B_Temp,TD
                btfss   STATUS,C
                bcf     B_Temp,TD
                movf    B_Temp,W
                movwf   PORTB
stop_bit        call    scix_end        ; 4 cycle delay
                nop
                nop
                bsf     PORTB,TD
scix_end        return
```

second whenever logging is in progress and when switch *S1* is pressed to indicate that the battery and microcontroller are "alive." Since the LED consumes about 3 mA of current (40 times as much as the processor), the switch allows you to turn it on occasionally to check that the Data Logger is functioning but otherwise ensures that no power is wasted flashing a LED that no one sees.

Switch *S1* also doubles as a "logging start" switch. With it, you can set up the Data Logger, carry it somewhere and begin logging exactly when you want.

PIC Software

The "magic" that makes all this work is the PIC16C71 software. With the 32-kHz crystal, the PIC can execute a mere 8,192 or fewer instructions every second. To put this into perspective, a typical PC runs 1,000 times faster while executing much more complicated instructions. Programming the ultra-low-power Data Logger is an exercise in coaxing maximum efficiency from every single instruction!

While the complete software listing is too long to publish here (it's available from the authors per the Note at the end of the Parts List), Listing 1 contains an essential piece of code that's especially important and unique to the low-power nature of this application, namely the interrupt-driven serial communication routines. Other parts of the code are described in less detail. The complete Data Logger software consists of:

(1) Serial interface code , which communicates with a PC.

(2) Command code, which processes data received by the serial interface.

(3) EEPROM interface code.

(4) Main program code.

(5) Initialization code.

• **Serial Interface.** You need to get information like time and temperature readings into and out of the Data Logger. While keyboards and LCDs are great companions for microcontrollers, they require parts, power and space—three things you're trying to minimize. Since the Data Logger spends most of its time alone, logging data, it really doesn't need a permanent user interface.

Your PC's serial port will work just fine for occasionally changing setpoints and dumping temperature data. This way, you get to use a full-size keyboard and a large-screen graphics display.

To make this work, the PIC16C71 needs a serial interface. Since the PIC16C71 doesn't have a serial interface, you must implement it entirely in software, using I/O ports and flipping on and off bits. This technique has been rendered almost unnecessary by serial interfaces done with hardware in higher-end microcontrollers, but it's still required for bare-bones PICs and many other low-cost devices. We'll give you a 1,200-baud, interrupt-driven serial communication routine you can use in any-low power PIC application.

First, a quick tutorial on serial communication. You'll find this invaluable if you've never had to do this with software. We'll restrict the scope of this discussion to the problem at hand.

The purpose of serial communication is to do with two wires what would otherwise require 10 wires. Most digital data comes in eight-bit packages, called bytes. To transfer a bit from one device to another requires one wire. So one byte requires eight wires—one per bit—to do the job. In addition, since data can be going in one of two directions, extra wires are needed to indicate which device is transmitting (sending) and which is receiving data. This accounts for the other two wires.

Rather than run 10 wires between each pair of devices that want to send bytes back and forth, you can send one bit at a time instead of all eight bits simultaneously. This is slower,

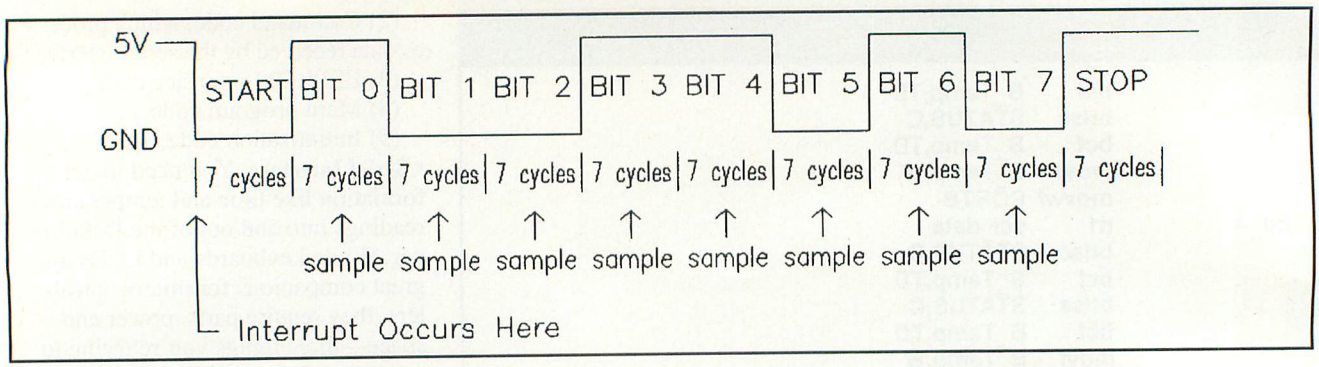


Fig. 3. Details of the serial data format.

but it's worth the savings in wiring and I/O pins. Rather than use two more wires to indicate direction, you can simply devote one wire to send bits in one direction and a second wire to send them in the other direction. Hence, each device has a transmitted data (TD) line and a received data (RD) line.

The transmitting and receiving devices must agree on how a byte is turned into individual bits sent down the wire. First, it's agreed that an "idle" line, while having no information to transmit, will be high (voltage present). This is equivalent to setting a PIC output bit to 1 with the bsf bit set file instruction. To indicate the start of each new byte, the line will be brought low (grounded) for a single bit period using the bcf bit clear file instruction. After this start bit, the actual data bits are sent in a low to high order (Fig. 3). Finally, after eight data bits are sent, a stop bit that must be a high level is sent. This comes to a total of 10 bit times for each eight-bit data byte.

Serial data transmission speed is usually given in baud, which is the maximum number of signal level changes per second. At 1,200 baud, each bit's time period is $^1/_{1,200}$ second, or 833 s. Because you're using such a slow clock to save power, the PIC can execute only 8,192/1,200 = 6.83 instructions during each bit time. To transmit information, you must take an eight-bit byte and, using only seven or fewer instructions, toggle a data line to properly convert the byte into a serial data stream.

Similarly, the PIC must be able to accept serial data and turn it into a complete eight-bit byte, again using less than seven instructions per bit period. All this must occur while keeping the timing reasonably close to $^1/_{1,200}$ second per bit.

At first glance, achieving proper timing looks hopeless because timing must be a multiple of the PIC instruction cycle of 1/8,192 = 122 µs. One bit, at 1,200 baud, is 833 µs in duration. The closest multiple, 7 x 122 = 854, is off by 21 µs. Fortunately, this error of about 2.5% is within the tolerance of modern serial communication circuits. So you'll be able to get away with treating seven PIC instruction cycles as one bit period.

Transmitting and receiving are handled very differently. The PIC must always be ready to receive data from the PC and doesn't know when it's coming. A common approach to this is to poll the serial line, looking for a start bit, with the btfsc bit test file, skip if clear instruction, as detailed in Listing 2.

In addition, time-keeping and data-logging work must be performed, which requires a fair number of instructions. The polling technique works fine if the Data Logger is able to poll often enough so as not to miss changes on the serial data line. Fast processors, running at megahertz clock speeds, have no problem with this task.

In this application, with a 32-kHz clock, if the Data Logger is writing data to EEPROM, which takes many milliseconds, it's certain to miss the entire serial character, which takes only 8.33 ms from start bit to stop bit. Characters sent by the PC to the Data Logger will, therefore, usually be missed. How can this problem be solved?

• **Interrupt-Driven Received-Data Routine.** The PIC16C71 offers a solution in the form of interrupts. Interrupts suspend normal processor operation and should be used only when an event external to the main processor occurs at unpredictable times and must be recognized immediately to prevent loss of data. The external event here is the occurrence of a start bit on the serial received-data line.

The PIC provides for certain I/O lines to generate a processor interrupt whenever the level on them changes. In particular, pin RB0 interrupts on a signal's rising or falling edge—just what's needed. As soon as the start bit drops the level on RB0, the PIC can stop executing its main program and start execution of a special interrupt routine. This interrupt routine is presented as Listing 1 and contains several critical details for PIC programmers.

First, the main program may very well have been interrupted at a point where data in working register W and status register STATUS is important. If you change these while in the interrupt routine, the main program will have the wrong W and STATUS when it returns to it. Hence, W and STATUS must be saved as the first task in the interrupt routine and then restored just before returning to the main program. (Many processors automatically save working registers when interrupted, though this requires additional time to respond to the interrupt.)

This deceptively simple task requires some odd code, as suggested in the Microchip data book, which includes the first three and last four (not including the retfie) instructions in Listing 1.

You must save and restore W and STATUS without accidentally modifying them. The obvious PIC instruction to use would be movf move file, but this instruction modifies the Zero bit of the STATUS register. The movwf

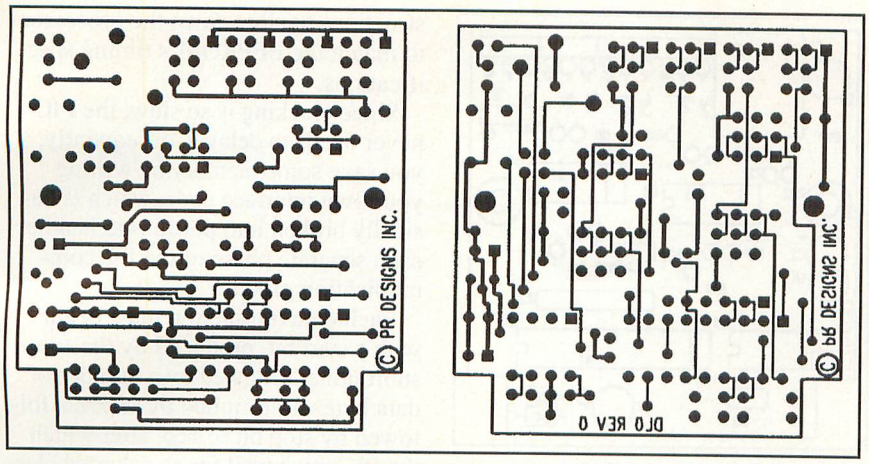


Fig. 4. Actual-size etching-and-drilling guides for component (left) and solder (right) sides of Data Logger printed-circuit board.

move W register to file and swapf swap file instructions are two of the few PIC instructions that don't modify the STATUS register. Hence, you use swapf twice (the second one reverses the effect of the first) to restore the registers without affecting the STATUS bits.

The PIC16C71's four possible interrupt sources are: TMR0, A/D, RB0 pin and RB4 through RB7 I/O pins. Any of the four interrupts generates exactly the same processor response, namely a jump to a common interrupt routine.

Once in the routine, the Data Logger must determine what caused the interrupt. This can be done by testing four special bits in PIC registers that are automatically set whenever a certain interrupt occurs. For example, if the RB0 pin changes, the INTF flag will be set. If INTF = 1, a serial communication start bit is in progress. If INTF = 0, one of the other three sources is responsible for the interrupt. Since the Data Logger doesn't use any other interrupts, it's assumed that INTF is the cause of every interrupt. In a program that uses the other interrupt sources, however, you'd have to test for the cause of every interrupt.

Always be certain to clear the cause of the interrupt before leaving the routine. The interrupt flags themselves, such as INTF, are what generate an interrupt signal for the processor. This flag doesn't automatically clear itself when the interrupt routine is exited. If an exit from the routine is done without doing something about the flag, another interrupt will immediately be seen by the processor. This false interrupt is caused by the flag from the previous interrupt and isn't a legitimate new event.

You're now caught in an infinite loop, processing false interrupts. Therefore, the INTF flag must be reset before the end of the interrupt servicing routine.

Finally, how is the serial data actually recovered? Remember that seven processor cycles equals one serial bit. The falling edge (high-to-low transition) of the start bit to the end of this bit requires seven instruction cycles. The next serial bit is data Bit 0, which, itself, is seven instruction cycles long.

Let's look at each data bit about half way through the bit time period. This makes our sampling process as insensitive as possible to timing errors. Therefore, we want to sample Bit 0 about 10 cycles after the start bit generates an interrupt and then sample every seven cycles thereafter (see Fig. 3).

The PIC16C71 requires four cycles to process an interrupt. The three instructions to save W and STATUS registers use three cycles. To prepare for receiving data, a bcf STATUS,C instruction, using one cycle, clears the carry bit. This totals eight cycles. Two more cycles are added by using a two-cycle goto instruction and then entering a loop to test the received data line and convert it into an eight-bit byte. The loop itself must take exactly seven cycles to closely match the bit time period. The final stop bit is ignored.

• **Transmitted Data Routine.** Transmitting serial data is much easier than receiving it because it's done on its own terms in terms of timing. When you're ready to send a character, you just do it. It then becomes the job of the receiving end to find the start bit and properly time the data. The code for transmitting serial characters is given in Listing 2.

The only requirement is that each serial bit time, as before, takes exactly seven processor cycles. First, comes a seven-cycle-long start bit. Then, for each data bit, the data byte is rotated, the carry bit is tested and the transmitted data output bit is set high or low, depending on the state of the carry bit. The code to transmit each bit must take exactly seven cycles, whether the bit is high or low. This is why the actual bit set and clear instructions change register B temp, rather than the actual I/O bit itself. If they modified the I/O bit itself, timing would depend on whether the bit is high or low. To prevent this, the B temp register is used and transferred to PORTB at the proper time for each serial bit. Each bit has its own code because seven cycles per bit doesn't provide enough time to perform a loop with decfsz and goto instructions. Finally, a stop bit must be generated.

• **Command Code.** While the foregoing serial interface code handles things at the bit level, you must define a set of instructions that tell the Data Logger what actions to perform. The command code accepts instructions from the PC as a series of bytes, the first of which is always an alphabetic character from a to z (upper-and lower-case are recognized as equivalent). This letter can be followed by any number of additional bytes, as required by the particular command. Specific commands for the Data Logger are:

a performs A/D conversion on all four channels and returns results, Channel 1 first.

i sets the data-logging interval. It expects two bytes, the first indicating the units of the second byte: 1 = seconds, 2 = minutes, 4 = hours. A value of 0 indicates that no logging is to occur. The logging interval value is in the second byte and should be 1 to 59 for seconds or minutes, 1 to 24 for hours. Logging begins, after the switch is turned on, on the next second, minute or hour increment, depending on the units of the interval value.

k sets the clock and expects two

bytes, hour and minute. It clears seconds to 00.

l returns log ctrl and log addr values, which indicate how much of EEPROM has been filled, as they're the current page and next free byte address. A third byte is also sent to indicate log full status: "ff" = full.

m sets recording modes. The single-byte argument has bits set as follows:

Bit 7—set to sample once/hour for min/max

Bit 6—set to sample once/minute for min/max

Bit 5—set to sample once/second for min/max

Bits 1,0—number of channels to record

Bits 0 and *1* are a value from 0 to 3, representing one to four channels. Channels can't be skipped. If Channel 4 must be logged, Channels 1 through 3 will also. If Bits 5 through 7 = 0, raw data is stored each sampling interval for the selected number of channels. If Bit 5, 6 or 7 = 1, the minimum and maximum for each selected channel since the last logging are saved. Sampling in this case occurs once per second, minute or hour, depending on which bit is set.

p sets EEPROM page number. It expects one argument, another "p" or a number specifying the page address for R and W commands. A second "p" returns current page setting.

r is the read EEPROM command. It expects two arguments: starting address of EEPROM locations to be read and number of bytes to read. The current page address must have been set by a "p" command. If there's an EEPROM read error at any byte address, transmission is terminated prematurely. To read an entire page (256 bytes), send "00" for the number of bytes to read.

s returns interval settings intvl1 and intvl2 and recording mode setting r modes. These are set with the "i" and "m" commands.

t returns clock hour, minute and second.

w writes one byte to EEPROM. This command expects two arguments: an address and then a data byte. Data is written to the EEPROM address. The current page as set by a "p" command is used.

x returns the min/max table for all four channels, in the order chan 1 min, chan 1 max ... chan 4 min, chan 4 max.

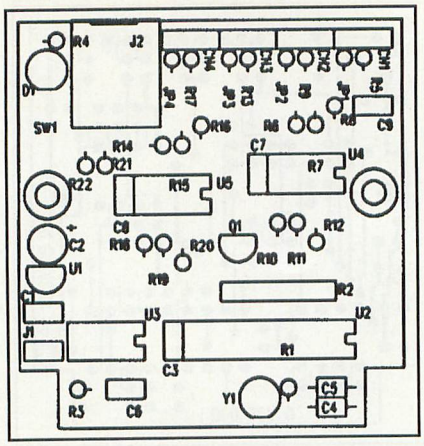


Fig. 5. Wiring guide for Data Logger pc board.

z resets log and min/max table. The command must be two "z"s in a row to execute. EEPROM page and address are set to the first data byte in page 0, and the log full flag is cleared, but no EEPROM data is erased. The min/max table is reset by doing a conversion on each A/D channel selected by the "m"ode command and setting min and max equal to the result.

• **EEPROM Interface Code.** Serial EEPROMs are very popular as an inexpensive form of nonvolatile storage. To keep down the size and cost of them, they use serial interfaces that, once again, require a software-based implementation on the PIC-16C71. Unlike the 1,200-baud serial interface, however, there are no exacting speed requirements. The EEPROMs don't care how slow you talk to them.

The I²C interface is almost like a serial communication port, but it requires two signals: clock and data. Rather than assume an exact time per bit, a separate clock line tells the EEPROM when each bit time occurs. The PIC always supplies the clock signal, and there's no limit as to how slow it can be. The EEPROM reads or writes one bit of data for each clock pulse. Data is 0 or 1, depending on the state of the data line when the clock line is high.

Details of the I²C interface are best found in data sheets for the devices themselves and manufacturers' application notes. There are many different ways to write the code, and Microchip provides some examples in its *Embedded Control Handbook*. The code assumes clock frequencies of 2 MHz and greater and includes many instructions to slow down the processor to match the EEPROM's timing specifications.

Since clocking is so slow, the PIC never needs to delay. Consequently, you save some memory by writing your own interface code, which is basically broken into portions to handle each separate phase of the I²C communication process.

Each data transaction must begin with a start bit, produced by the iic start subroutine; followed by a number of data bytes, transmitted by iic putch; followed by stop bit iic stop; after which the PIC must wait for an acknowledge from the EEPROM, iic wack. For receiving data from the EEPROM, subroutine iic getch accepts data, and iic ack provides an acknowledgment from the PIC to the EEPROM. The sections of code named iic write and iic read use the above subroutines to handle entire write and read transactions.

• **Main Program Code.** The main program has three principal functions: keeping track of time, measuring the inputs and storing the results to EEPROM.

Time. 32-kHz watch crystals are inexpensive and readily available simply because they're so popular for keeping time. Their actual frequency is 32,768 Hz—an exact power of 2—which makes them perfect for all circuits that count in binary, including microcontrollers. By design, the PIC-16C71 divides this frequency by 4 for a resulting 8,192 Hz . Since 8,192 is 2^{13}, a 13-bit counter will overflow every 8,192 counts or, in our case, once every second. This makes a great clock.

The PIC can easily make a 13-bit counter with its timer TMR0 (also referred to as the RTCC, real-time clock and counter). Although TMR0 is only eight bits itself, it can be driven by a programmable eight-bit prescaler, effectively producing a 16-bit counter. The programmable nature permits the prescaler to act like a counter consisting of just one or as many as eight bits, dividing its clock by a factor of $1/2$ through $1/256$. You select $1/32$ division, which is like a five-bit counter. Added to TMR0's eight bits, this makes your 13-bit counter.

Lastly, you select the processor clock as the input to the prescaler. Now, once a second, TMR0 overflows and sets the T0IF (Timer 0 Interrupt)

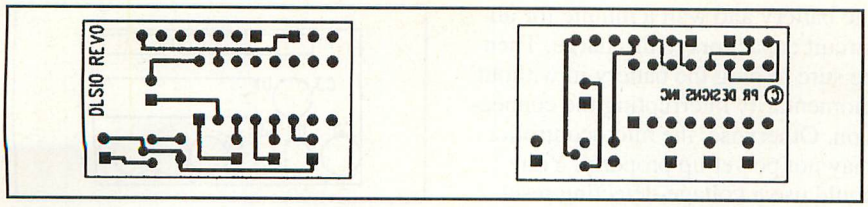


Fig. 6. Actual-size etching-and-drilling guides for component (upper) and solder (lower) sides of serial-interface pc board.

flag in the INTCON register. By testing this flag at least once per second, you'll know when a full second has elapsed. You then count seconds from 0 to 59 and increment the minutes count. Similarly, you count minutes from 0 to 59 and then increment the hours count. Finally, when hours reaches 24, you zero all three counts.

For your own designs, you might want to remember that TMR0 can generate a processor interrupt. The interrupt service routine could then perform time-keeping functions. We didn't choose this route for two important reasons. One is that we're never so busy that we can't check the T0IF flag at least once a second and, thus, don't have to worry about losing time. The other is that this would complicate the interrupt service routine and make it possible for a serial communication bit to be missed while playing around with the time. The moral of this example is: use interrupts only when absolutely necessary. They can easily cause more problems than they solve!

• **Measure Inputs.** Every second, the program decides if it's time to take input readings or store values. It does this by looking at the interval and operating mode settings. The mode setting tells how many inputs are to be measured. Each is selected for measurement by setting two bits in the PIC16C71's ADCON0 register. Then the A/D converter is operated by setting the GO flag. The result shows up about 6 µs later in the ADRES register. For regular data logging, the datalog subroutine operates the A/D converter and stores the results.

• **Store Measurements.** Input readings must be stored to EEPROM at an interval set by the user. This requires comparing actual time with desired sampling interval. When the two match, the datalog subroutine stores the required number of channel values to the EEPROM.

As an alternative to interval sampling, many applications require that only the maximum and minimum values over a certain period of time be recorded. For instance, historical weather data used to calculate heating and cooling degree days looks at only the maximum and minimum temperatures for each 24-hour period. If this is all you need, there's no reason to store temperature values every hour. However, you must decide how often to take measurements and update the minimum and maximum values.

In min/max recording mode, the Data Logger can be set to measure the inputs once per second, minute or hour. You should use as slow a setting as possible to conserve power. Use of min/max recording mode can save a lot of memory and let the Data Logger operate for a long time unattended. As an example, logging only min/max values for two temperature transducers on a daily basis, the Data Logger can operate unattended for more than 500 days (with a suitable battery) before memory is filled!

For min/max recording, a minmax subroutine is called, based on the sampling interval specified by the mode. It compares the input value to minimum and maximum values stored in processor registers and determines if either needs to be updated. The datalog subroutine is called, based on the interval setting to store both minimum and maximum values for each selected channel in EEPROM.

• **Initialization Code.** The first piece of code is discussed last because its only after everything else is designed and written that you know what processor features, registers and bits are needed to do the job. The init section of code clears all registers to 0 because many sections of code expect flags and data bytes to be 0 when the Data Logger is first turned on. Also, I/O pins must be defined as input or output, analog or digital, and be properly set to 0 or 1. The serial interface transmitted-data line, for example, must idle high and is, therefore, set to 1 in the initialization code. The EEPROM address for logging is also initialized to the first available location following the calibration data.

Construction

Before building the Data Logger, it's best to decide what you want to measure and select transducers accordingly. Components *JP1* through *JP4*, *R5*, *R6*, *R9*, *R10*, *R13*, *R14*, *R17* and *R18* depend on the transducers being used. Channel 1's *JP1* through Channel 4's *JP4* permit a low-power reference diode to be inserted to provide a voltage offset for certain transducers that require a negative power supply. If you don't need this feature, you must install a 0.1" jumper wire. The resistors are selected to attenuate transducer output voltages that are greater than the maximum 2.5-volt input for the channel amplifiers.

Where attenuation isn't required, it's a good idea to use a 10,000-ohm resistor in series with the input to prevent damage to the op amps if an input is accidentally tied to a voltage that's greater than its power supply potential.

With so few components and interconnections, the Data Logger is easy to build on a perforated board identical in size to the printed-circuit-board artwork shown in Fig. 4, using point-to-point techniques. (Ready-to-wire bare pc boards and assembled units are available, as detailed in the Note at the end of the Parts List.)

The board has two No. 4 machine-screw holes for mounting. Mark each connection with a yellow felt-tip marker on Fig. 1 as you place it. Parts placement should be similar to the layout shown in Fig. 5.

Use sockets for the DIP ICs so that any errors in wiring can be corrected without damaging IC pins.

You can use No. 28 Wire Wrap wire for all connections, although No. 26 or No. 24 is preferred for power wiring if you're using transducers that draw more than a few hundred microamperes. It's good practice to wire analog and digital grounds separately back to the power supply to prevent introducing digital switching noise into the analog circuits. This means

that the microcontroller and EEPROM grounds are on one branch of wiring, with the transducers and op amps on a separate branch. Tie both together at *U1*.

Program the PIC16C71 with the Data Logger code. Both source and object code are available from the source given in the Note at the end of the Parts List. If you don't have access to a programmer, you can purchase a programmed version of the PIC from the same source. The part listed is a One-Time-Programmable (OTP) version, which means that once it's programmed, there's no way to change the code. Microchip makes a windowed version that can be erased with ultraviolet energy, though it costs about twice as much as the OTP variety.

For outdoor use, seal the enclosure to make it watertight. Remember, though, that the complete Data Logger contains a battery and ICs, both of which have limited temperature operating ranges (0° to 70° C for the PIC16C71 and less of a range for most batteries). Therefore, you may want to keep the Data Logger indoors and just place the transducers outdoors.

Mount the temperature transducers on the ends of lengths of three-conductor cable and pot them in silicone, though a thermally conductive compound is preferable for faster response to temperature changes.

You also need a serial interface cable for the PC, including the RS-232 level translator. This simple circuit uses only a few components, which can fit inside a null-modem-type plastic shell designed for 25-pin serial connectors, along with the 25-pin DB-25S (S indicates socket style, as opposed to a plug with pins) connector itself. Actual-size artwork for a printed-circuit board for this circuit is given in Fig. 6. The wiring guide for this assembly is shown in Fig. 7. If you prefer not to build this circuit yourself, you can purchase an assembled unit.

An important characteristic of low-power oscillator circuits should be mentioned at this point. They don't start oscillating instantly upon application of power. In fact, the one here can take half a second or longer to get up to speed. So if your Data Logger doesn't seem to operate properly when power is first applied, remove the battery and wait a minute for all circuit capacitors to discharge. Then be sure to plug the battery in without momentarily interrupting the connection. Otherwise, the microcontroller may not power up properly. You could use a voltage-detecting reset chip to eliminate this potential problem, but the extra cost and power consumption don't justify it since power is turned on and off only when the battery is replaced.

Calibration

To use many varieties of transducers with the Data Logger and provide for the most accurate readings possible, a number of calibration procedures and values are required. Circuit calibration data is used to ensure that the A/D converter properly measures voltages. Transducer conversion data is used to describe what kind of transducer is attached to the Data Logger, as well as to maximize the accuracy of readings.

• **Circuit Calibration.** The Data Logger has only one significant source of error—the A/D converter's VREF voltage reference. The A/D converter converts an analog signal into an eight-bit digital value that ranges from 0 to 255 (0 to FF hex). The calibration process defines the full-scale (maximum) analog voltage. This value is whatever the A/D converter uses as a reference.

The PIC16C71 gives you the option of using any full-scale reference equal to or less than its positive supply voltage or using the supply voltage itself as the reference. The latter saves on parts and power consumption. Hence, in the Data Logger, the LM2936 voltage regulator also serves as the A/D converter's reference. The only downside to this is that the LM2936's output is 5.0 volts ±3% as it comes from the factory. When used as a reference, your temperature readings could then be in error by ±3%.

For 100° C full-scale, this is ±3°, which is a fairly significant error. One possible solution would be an adjustable power supply. Unfortunately, the LM2936 isn't available in an adjustable version. Fortunately, there's a simple solution that doesn't even require a trimmer.

The output voltage of the LM2936 is very stable with time and temperature. The major error factor is initial output voltage. By just measuring this and using the value to correct all data readings, you can completely correct for this error. The EEPROM is a very handy place to store the calibration value. The first two bytes of EEPROM are used to keep the A/D VREF reference voltage. The data-logging software makes sure these bytes are never overwritten by transducer data.

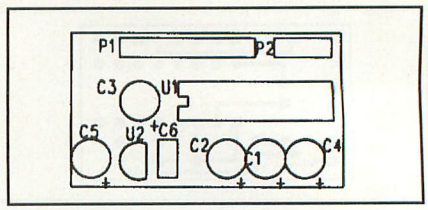


Fig. 7. Wiring guide for serial-interface pc board.

Calibration simply requires that you measure the 5-volt power supply with an accurate digital voltmeter and record the value in the EEPROM. Then, whenever data values are read, this value should also be read and used to correct the data. This is done by first dividing each data value by 256 to obtain the fraction of full-scale and then multiplying by the reference voltage. The result is the actual voltage measured by the A/D converter. The equation for this is:

$$A/D\ V_{in} = (ADRES/256) \times VREF$$

where ADRES is the eight-bit A/D conversion result in the PIC16C71 register ADRES, and VREF is the measured reference potential, which is nominally 5.0 volts.

• **Transducer Conversion.** If you want to measure some physical variable—temperature, barometric pressure, humidity, rainfall, etc.—you must locate a transducer that can measure what it is you want to measure. The Data Logger requires only that the output of the transducer be a voltage signal. Since the A/D converter has a 0-to-5-volt input-signal range, the Data Logger's op amps amplify transducer output to use as much as possible of the 5-volt range.

To convert this voltage into engineering units (such as degrees), you must specify, at most, two numbers —gain and offset. This works for only linear transducers. If your transducer, has an output that isn't a linear function of temperature, such as a thermis-

Temperature Transducers

Temperature is the most-measured variable in the world! Consequently, there are more ways to measure it, and a greater choice of measuring devices, than for anything else. The most common transducers utilize thermocouples, variable resistance-sensing elements or solid-state sensors.

Thermocouples are made of two pieces of wire of different material fastened together at a point. This creates a very small electrical signal (microvolts per degree) that changes with temperature. A reference temperature is required, which is usually simulated with an electrical circuit. Hence, use of thermocouples requires a fair amount of electronics, though it's possible to purchase ICs that include most of what's needed (Analog Devices AD594/595, for example). The complexity of using them is offset by the fact that thermocouples are able to measure a range of temperatures unequaled by anything else, from virtually absolute zero (–273°) to 2,300° C.

Resistance devices include the RTD (Resistance Temperature Detector) and thermistors. RTDs are usually made from platinum, making them more expensive than thermocouples or thermistors, though they're extremely accurate and the most linear—and the least rugged—of the three devices. RTDs are used over the range of about –200° to +800° C.

Thermistors are very nonlinear, low-cost devices that measure from about –50° to +300° C. Both RTDs and thermistors have an enormous advantage over thermocouples in that their change with temperature (ohms per degree) is easily converted to many millivolts per degree, as opposed to the microvolts provided by thermocouples.

By far the easiest device to use is the solid-state IC temperature sensor, which is inherently linear and has very good accuracy due to factory laser trimming of circuit elements. They're the least-expensive choice, considering that their outputs need little, if any, amplification and no correction for nonlinearities like thermocouples, thermistors and RTDs. The only disadvantage is a restricted measuring range of about –50° to +150° C.

The most common IC devices are the National Semiconductor LM34/35 series that output 10 millivolts per °F (LM34) or °C (LM35). The least-expensive of these devices (LM34D/LM35D) work over a 32° to 212° F (0° to 100° C) range. You can use more-expensive versions (LM34C and LM34) for extended ranges of –40° to 230° or –50° to 300°. For °C versions, the LM35C and LM35 extend the ranges to –40° to 110° and –55° to 150°. Typical current consumption is only 75 µA, and accuracy is typically ±1.2° at room temperature. An obvious difficulty is that 0° is 0 volt output. So a negative power supply, or an offset reference, must be used to measure temperatures below 0°.

The best device for measuring temperatures below 0° is the AD22100 from Analog Devices, which operates from a single 5-volt supply and has the offset built-in so that a 0.25-volt output represents –50° C and a 4.75-volt output represents 150°. Like the National part, three versions are available. The "K" suffix measures 0° to 100° C, the "A" suffix measures –40° to +85° C and the "S" suffix measures the full –50° to +150° C. Note that the AD22100 draws about 10 times as much power as the National chips. This isn't a problem with the Data Logger, in which power to the transducers is turned on only to make measurements, but it would be important in battery-powered circuits that must have the transducer operating all the time.

If the 200° range of these IC sensors is more than you need, you can trade a narrower range for greater resolution. Remember that the A/D converter turns a 0-to-5-volt signal into a number from 0 to 255 (although full-scale is considered to equal 256). Therefore, the 200° range represented by a 0.25-to-4.75-volt signal from the AD22100 means that the A/D output ranges from (0.25/5) X 256 to (4.75/5) X 256, or about 13 to 243. This total output range of 243 – 13 = 230 must represent 200°. Therefore, each increment is 200/230 = 0.87°, which is the resolution or minimum change that can be detected. If you want better resolution, say twice that or about 0.435°, provide additional amplification so that the 5 volts full-scale of the A/D converter will be reached at 100° instead of 200°.

A variety of transducer circuits is shown in Fig. 8 that use both the National and Analog Devices parts. Choose ones to meet your desired temperature range and use the most readily available components. Figure 8 also indicates the required offset and gain numbers to use with the Data Logger. Refer to the section on Transducer Conversion for information on what these numbers do.

tor, more-sophisticated math must be performed by the PC after reading the A/D values.

The Data Logger lets you store these gain and offset values in EEPROM, where they're readily available. A PC Data Display Program, described later, automatically uses these to plot data in the proper engineering units, using the equation:

$$\text{Value} = (\text{A/D } V_{in} + \text{Offset}) \times \text{Gain}$$

where A/D V_{in} is the number calculated as described previously.

The procedure for connecting virtually any transducer to the Data Logger, using the AD22100A temperature transducer as an example, is as follows:

(1) Decide upon the range over which the transducer is to operate. The AD22100A measures –40° to +85° C, producing an output of 0.475 to 3.288 volts over this range. Since the 3.288 value is greater than the 2.5-volt maximum you want for the Data Logger, you attenuate by a factor of 2.5/3.288 = 0.76. Resistors of 10,000 and 3,160 ohms provide this. To change this into the A/D converter's 0-to-5-volt input range, you then need a gain of 5/2.5 = 2. Op amp gain is calculated as R6/R7 + 1 (for Channel 1). With R6 = R7 = 10,000 ohms, you obtain a gain of 2. Now you have a (0.475-volt x 0.76 x 2) = 0.722 volt to (3.288 volt x 0.76 x 2) = 4.998 volt signal representing –40° to +85° C.

(2) Determine the transducer's "offset." This is the voltage that represents a 0 output, in this case 0° C. For the AD22100A, this number is 1.375 volts. The combination of attenuator and op amp gain changes this to 1.375 x 0.76 x 2 = 2.09 volts. The actual offset is the negative of this because this number, when subtracted from a 2.09 volt reading, produces a 0 result.

(3) Determine the transducer's "gain." This is the number by which to multiply (input voltage – offset) to obtain the value of what's being measured. For the AD22100A, this is (4.998 – 2.09) = 2.908 for an 85° reading. Therefore, the gain is 85/2.908 = 29.23.

(4) If you want a readout in °F instead of °C, remember the conversion equation °F = 9/5 x °C + 32, or °F = 9/5 x (°C + 17.78). Recalculate offset as the transducer voltage for –17.78°, since this is where °F will = 0. At –17.78° C, the transducer poten-

tial is 0.975 volt that when multiplied by 0.76 and 2 becomes 1.482. Since, as before, this must be subtracted; make the gain –1.482. Recalculate gain as (4.998 – 1.482) = 3.516 volts for 85° C = 185° F. So gain is 185/3.516 = 52.617. Alternatively, gain is simply 9/5 times the °C gain, and, indeed, 9/5 x 29.23 does equal 52.614 (rounding errors account for the insignificant 0.003 difference).

A second use of the transducer calibration values is to correct for errors in the transducers themselves. If you have access to a very-accurate temperature-measuring instrument, you could use it to determine very-accurate gain and offset values for each temperature transducer. However, this isn't usually necessary, as transducers come from the factory trimmed to a typical accuracy of ±1°.

In addition to the above, the gain of the op amp circuits and attenuators has been assumed to be accurate. Using a pair of 1%-tolerance resistors, however, produces a possible error of about 2% for each. If you're able to measure the input and output of the circuit while it's operating, you can completely correct for this error by changing the gain constant.

Lastly, certain transducers are "ratiometric" in nature, meaning that their output is directly proportional to the voltage supplied to them. Thus, if transducer output is 1 volt with a 5-volt power supply and the power supply is changed to 5.1 volts, the output would increase by a factor of 5.1/5, to become 1.02 volts. With the ratiometric AD22100 temperature sensors, you can increase the Data Logger's accuracy by measuring VREF as described above and using VREF to change the offset and gain constants, as shown in Fig. 8.

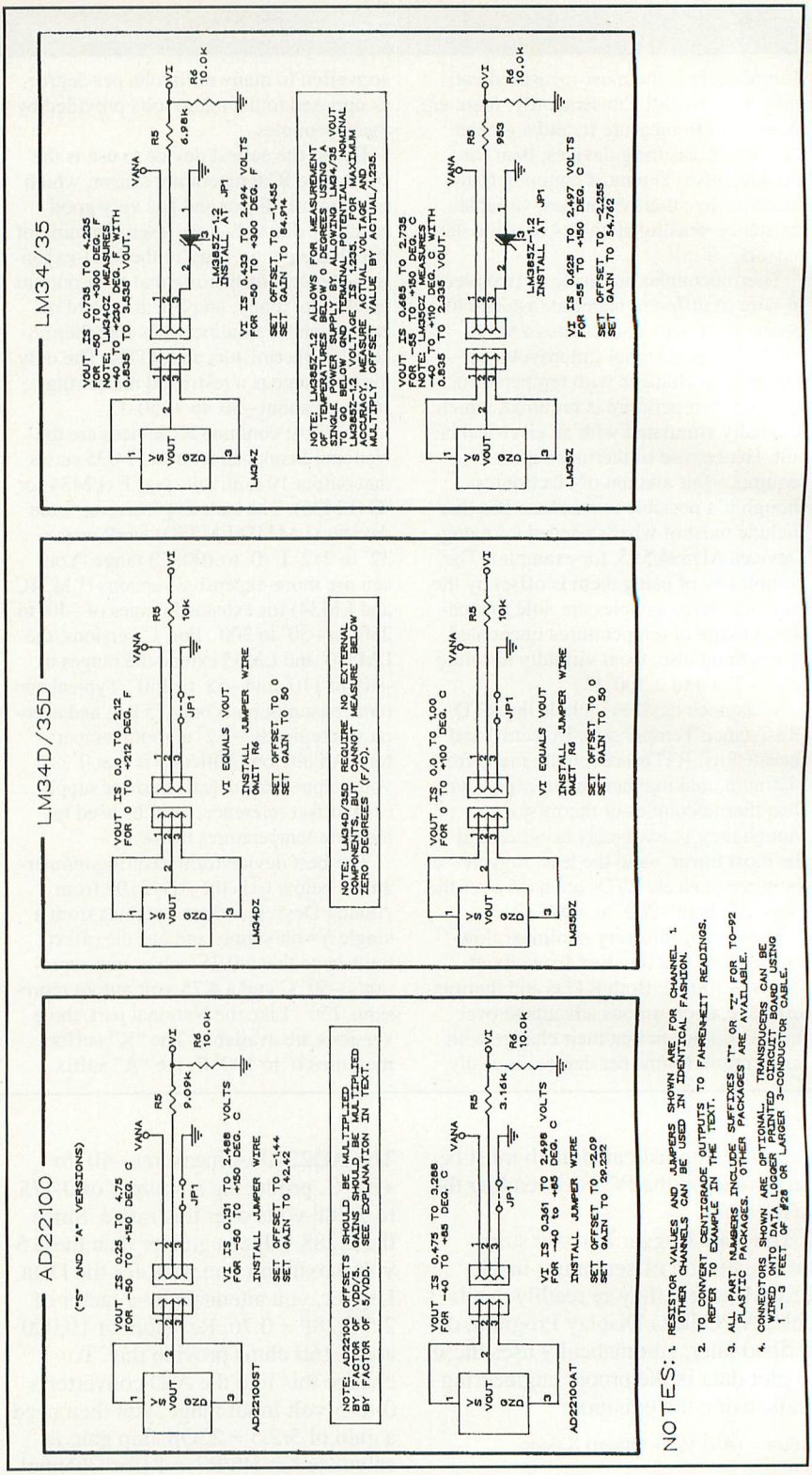


Fig. 8. Temperature-transducer hookup and calibration constants details.

Using the Data Logger

You can set up the Data Logger's sampling interval and recording modes with your PC and a communications program, such as *Procomm*. However, you'll quickly run into the inconvenience of dealing with eight-bit data, which most communications programs don't provide an easy way to generate. When you want to read the stored temperature values, you'll receive eight-bit binary data that must be converted from the A/D output values to actual temperatures and corrected with the stored reference voltage value. Finally, you'll probably want to plot the results.

You can write a program to do this, or you can obtain the one referenced in the Parts List that not only provides a *Windows*-style facility for setting calibration constants, time and operating setpoints but also converts, plots and stores the logged data. The PC screen consists of a menu bar at the

top with pull-down sub-menus and the main display area. The menu choices and sub-menus are:

• **SETUP** selects the PC's serial communication port.

PORT chooses from among COM1 through COM4.

SAVE saves setup and returns to the main menu.

• **CAL** sends calibration values to the Data Logger. Reference voltage and both offset and gain are represented by signed two-byte values stored in the Data Logger's EEPROM. An implicit decimal point is between the two bytes. So values range from ±0.004 (1/256) to 127.996 (127 + 255/256).

VREF is the Data Logger's power supply and A/D converter reference voltage.

CH 1 is the offset and gain values for Channel 1.

CH 2 is the offset and gain values for Channel 2.

CH 3 is the offset and gain values for Channel 3.

CH 4 is the offset and gain values for Channel 4.

READ VALUES reads and displays all calibration values from the Data Logger.

• **SETPOINTS** sends operating constants to the Data Logger.

LOGGING INTERVAL is 1 to 59 seconds or minutes, 1 to 24 hours or disable logging.

CLOCK sets the Data Logger's 24-hour clock hour and minute.

SAMPLING RATE selects minimum/maximum or normal recording and sampling rate for min/max.

CHANNELS is the number of channels to record (one through four).

READ VALUES reads and displays all the above values from the Data Logger.

• **SHOW DATA** displays current readings.

CHANNELS displays calculated values for all enabled channels.

MIN/MAX displays calculated minimum and maximum for all enabled channels.

• **LOG** retrieves and plots data logs, checks status and resets.

RESET resets the Data Logger to begin a new log.

STATUS displays the percent of log memory used.

READ retrieves the log from the Data Logger.

GET retrieves the log from disk.

SAVE saves the current log to disk.

TYPE displays log values on the screen in list format.

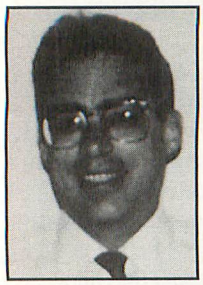
PRINT prints log values on the printer in list format.

GRAPH plots log values for selected channels on the screen.

• **EXIT** quits the program.

When setting calibration constants, there may be a slight discrepancy between the number you enter and the number read back from the Data Logger. This is due to the fact that only 16 bits (two bytes) are used to store the constants.

We hope this Ultra-Low Power Data Logger is helpful in designing your own battery-powered projects. If you have any suggestions you'd like to see implemented or require any technical assistance or advice, please call us at 508-470-0498 between 9 A.M. to 5 P.M. Eastern Time and we'll do our best to help. ■



By Joe Desposito

Computing On The Go

Plug 'n' (Sometimes) Play

If this were a perfect world, Plug 'n' Play would be more than a buzzword, and installation headaches would be a thing of the past. Obviously, this isn't a perfect world, but every so often, I encounter a product that embodies the spirit of Plug 'n' Play. Such is the case with Shuttle Connection from Shuttle Technology.

The $130 Shuttle Connection is a parallel-to-SCSI adapter. It looks almost like an ordinary cable with a 25-pin male parallel-port connector on one side and an SCSI connector on the other. In the middle of the cable, though, is a 25-pin female parallel port connector.

I plugged one end of Shuttle Connection into the parallel port of my Toshiba T3400CT ultra notebook computer and the other end into a Toshiba XM-4100A portable CD ROM drive. Then I installed the software that comes on a single disk (a second disk is included for use with OS/2). During installation, the software gave me two items of information:

```
Read Type: Toshiba Fast
Transfer Rate: 190 KB/sec
```

Shuttle Connection can take advantage of the new enhanced parallel ports (IEEE 1284), with possible transfer rates as great as 1.5M per second. Since the parallel port on the T3400CT isn't this newer type, the device defaulted to the slower rate.

To test whether the transfer rate was really 190K/s, I copied a 4.2M file from a Kodak Photo CD to my hard disk. This took 35 seconds. If you work out the math, the actual rate is closer to 120K/s for this type of operation. I compared this to the performance of the Adaptec SlimSCSI PCMCIA SCSI card. This setup did the same transfer in 20 seconds —almost twice as fast.

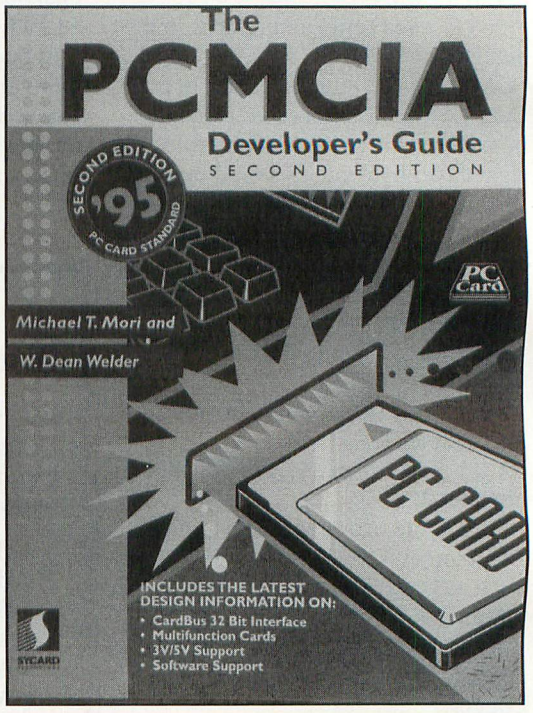
Shuttle Connection works with other SCSI devices, such as hard-disk drives, Syquest drives, Bernoulli drives, magneto-optical drives, tape drives and image scanners. As with other SCSI interfaces, Shuttle Connection lets you daisychain up to seven devices.

I tried printing a Microsoft Write document with Shuttle Connection in place and experienced no problems, though the manual warns of possible conflicts when running *Windows*. The printer connects to the parallel port in the center of the cable.

Overall, Shuttle Connection is as close to Plug 'n' Play as you can get. Besides installing the cable, all that's needed is a short software installation. This is also the type of product you can easily move from one computer to another, whether it's a portable or a desktop machine. If you need a SCSI port, Shuttle Connection is a good choice.

So Much for Leverage

There's a darker side to Plug 'n' Play. I had been anxiously awaiting a new product from SCM Microsystems called the SwapBox Combo. This is a combination 3½" floppy drive and Type III PCMCIA slot that sells for $199. It gives the convenience of a PCMCIA socket, without taking up a drive bay. The socket also gives you a chance to leverage your investment in any PC Cards you've obtained for your portable computer.



The PCMCIA Developer's Guide, Second Edition, gives latest design information on CardBus 32-bit interface, multifunction cards, 3-volt/5-volt support and software support.

To install SwapBox Combo, you simply remove your old 3½" floppy drive and replace it with the Combo. You also need to plug a 16-bit ISA PCMCIA interface card into a free motherboard slot and connect together the Combo and interface card with two ribbon cables. No jumpers need be set for interrupts or I/O ports.

After the hardware is installed, you install the software, which consists of *CardSoft* (DOS) and *CardView* (*Windows*) PCMCIA software, both Version 3.1, from SystemSoft. This software configures the Combo drive for use with all PCMCIA memory and I/O cards (Fig. 1 and Fig. 2).

After installing the software, I was ready to try out the PCMCIA socket with a few PC Cards I have on hand. The first one was an ATA flash card from SunDisk. This worked fine. The next was the TDK DF2814 Data/Fax Modem Card. For some reason, neither *Procomm* for DOS nor *CommWorks for Windows* recognized the modem. Both the *CardSoft* and *CardView* software recognized it, though. Strangely, the SystemSoft software assigned the modem to

COM3 and IRQ5, even though the usual COM2/IRQ3 combination was available.

This wasn't the first time I had trouble with the TDK modem. I also had a difficult time trying to get it to work with my T3400CT. In that case, I used a utility program supplied by TDK to solve the problem. I ran the same program here, but without success. After trying a few other things, I put aside the modem.

Next, I checked out the SlimSCSI PC Card and Toshiba XM-4100A portable CD-ROM drive. After plugging the card into the Combo, I attempted to access the CD-ROM drive. Although I could see the CD-ROM disk spinning in the drive, I kept getting error messages. Again, I tried everything I could think of to get the SCSI card to work, but I failed with this one, too. I thought about calling tech support but decided not to. Instead, I'm going to read the two manuals from cover to cover to see if I can discover what's going wrong. So much for Plug 'n' Play.

After completely removing and installing the SwapBox Combo, I tried the TDK modem again. This time, the SystemSoft software assigned the modem to COM2, and the modem worked. I scratched my head over this. I was happy to see that the modem was working but unhappy about the inconsistencies that were evident. One other thing. Whenever you plug in or remove a PC Card while in *Windows*, a long annoying beep sounds.

If you're trying to leverage your investment in PC Cards by adding a PCMCIA reader/writer to your desktop system, the SwapBox Combo is certainly a product to consider. However, I strongly suggest checking for compatibility with your PC Cards before you spend your money.

Products Revisited

Readers of this column know that lots of things go wrong with the products that I review here. Two companies decided to correct the problems and try again. One is CardDock from Greystone Peripherals, which I reviewed in my last column. After working for a while, CardDock just died. I sent it back, and Greystone sent me a replacement.

I reinstalled CardDock in my system and tried it with the same three PC Cards I used with the SwapBox Combo. CardDock immediately recognized the ATA flash card from SunDisk. When I tried the TDK modem, I had success, too.

When I installed the SlimSCSI card, CardDock seemed to recognize it. But, as with the Combo, the EZSCSI software wouldn't recognize the SlimSCSI card. So I got about the same results as before—two cards worked and one didn't. One other item to note: The insert and remove

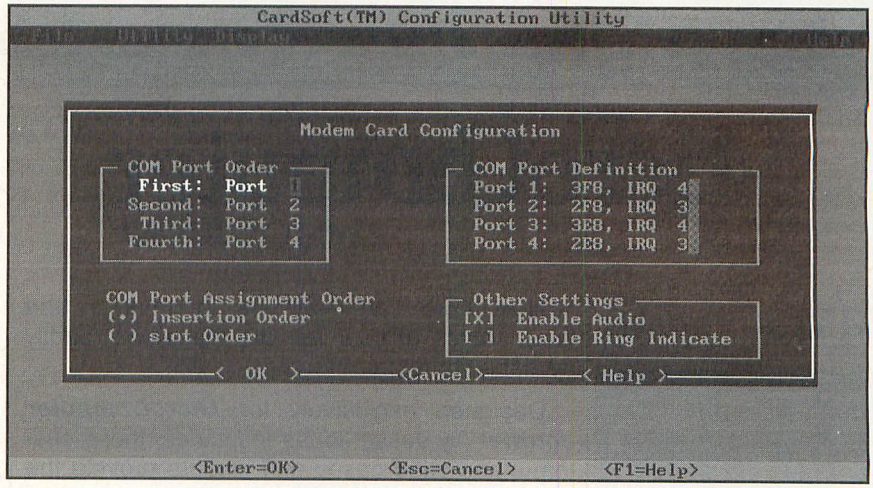


Fig.1. CardSoft Configuration Utility screen.

beeps were normal in *Windows* with CardDock, which uses Award PCMCIA software.

The other product I tested again is Travel Floppy from Accurite. The first time around, Travel Floppy was incompatible with the Hewlett-Packard OmniBook 300 I have. I was disappointed at this because this notebook really suffers without an external drive.

Installing the new software entailed copying it from the included floppy disk to the OmniBook. This I did by removing one of OmniBook's flash disks and plugging it into the PCMCIA socket on the Toshiba, which has its own external floppy drive. Then I copied the files from the floppy disk to the flash disk and reinserted the flash disk in the OmniBook. Once the software was on an OmniBook disk, I added a DEVICE=PPCFD.SYS line to my CONFIG.SYS file and rebooted.

All that was left was to plug the Travel Floppy PC Card into one of the empty PCMCIA sockets on the OmniBook (it has four, two of which hold flash disks). When I plugged in the card, I got a message in *Windows* that informed me it didn't recognize the card and that I should install the required device drivers, which I had already done. I clicked on OK and then opened the file manager. The floppy drive was there as drive F:.

According to Accurite, the Passport Card now supports the various models of the OmniBook, as well as a variety of other subnotebooks. The card also supports the HP 100 and 200 LX palmtop computers with a driver called FDHPPALM.SYS.

Developer's Guide

If you're interested in the development side of PCMCIA, Sycard's $89.95 *The PCMCIA Developer's Guide—Second Edition* by Michael T. Mori and W. Dean

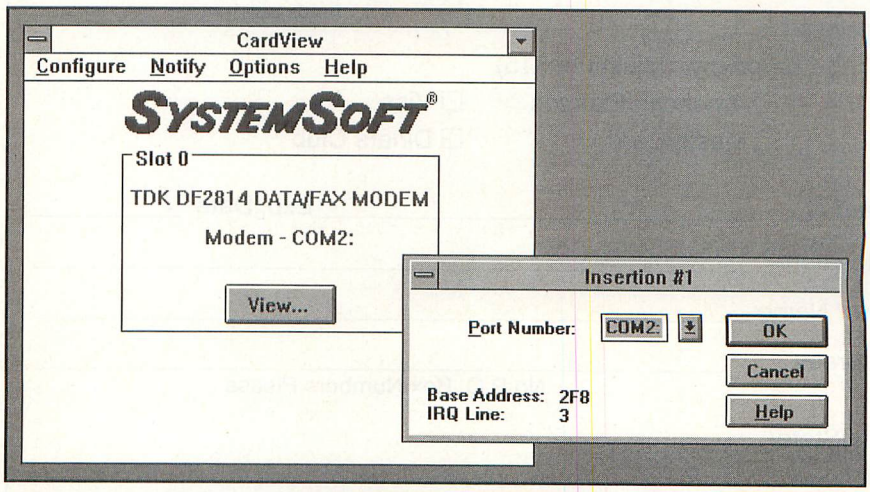


Fig. 2. SystemSoft CardView screen identifies item plugged into PCMCIA slot and gives Port, Bass Address and IRQ Line details.

Product Information

The Shuttle Connection
Shuttle Technology
43218 Christy St.
Fremont, CA 94538
Tel.: 510-656-0180

CIRCLE NO. 180 ON FREE INFORMATION CARD

SwapBox Combo
SCM Microsystems, Inc.
131 Albright Way
Los Gatos, CA 95030
Tel.: 408-370-4888; fax: 408-370-4880

CIRCLE NO. 181 ON FREE INFORMATION CARD

CardDock
Greystone Peripherals, Inc.
130-A Knowles Dr.
Los Gatos, CA 95030
Tel.: 408-866-4739; fax: 408-866-8328

CIRCLE NO. 182 ON FREE INFORMATION CARD

Travel Floppy
Accurite Technologies, Inc.
231 Charcot Ave.
San Jose, CA 95131
Tel.: 408-433-1980; fax: 408-433-1716

CIRCLE NO. 183 ON FREE INFORMATION CARD

PCMCIA Developer's Guide
Sycard Technology
1180-F Miraloma Way
Sunnyvale, CA 94086
Tel.: 408-749-0130; fax: 408-749-1323

CIRCLE NO. 184 ON FREE INFORMATION CARD

Welder provides a comprehensive overview of the PCMCIA PC Card Standard, along with design examples and reference materials. This new edition covers the 1995 release of the PC Card standard. At more than 600 pages, this book introduces the components that make up PCMCIA specifications and follows this up with practical information on designing PC Cards, hosts and software drivers.

Major enhancements of the second edition include a greatly expanded software section and practical design information on the new components of the PC Card standard, including the 32-bit CardBus, multiple function cards and low-voltage support. Also new is a utility diskette that contains PCMCIA-related tools, sample source code and application notes.

The *Guide* includes an extensive directory of PC Cards, host computers and desktop host adapters. An OEM directory gives information on components used in PC Card products. ■

By Ted Needleman

Microcomputer Musings

My Card, Sir...

Once again, I offer a mixed bag of PC products that are worthy of your consideration. I lead off with a nifty business-card design/printing software package. I follow with a review of a data watch that works in concert with software to do an amazing number of things. More about this gem later. Then I look at really high-quality photos on CD-ROM. Finally, I review a stereo speaker system that gives high-quality sound from tiny boxes.

Business-Card Software

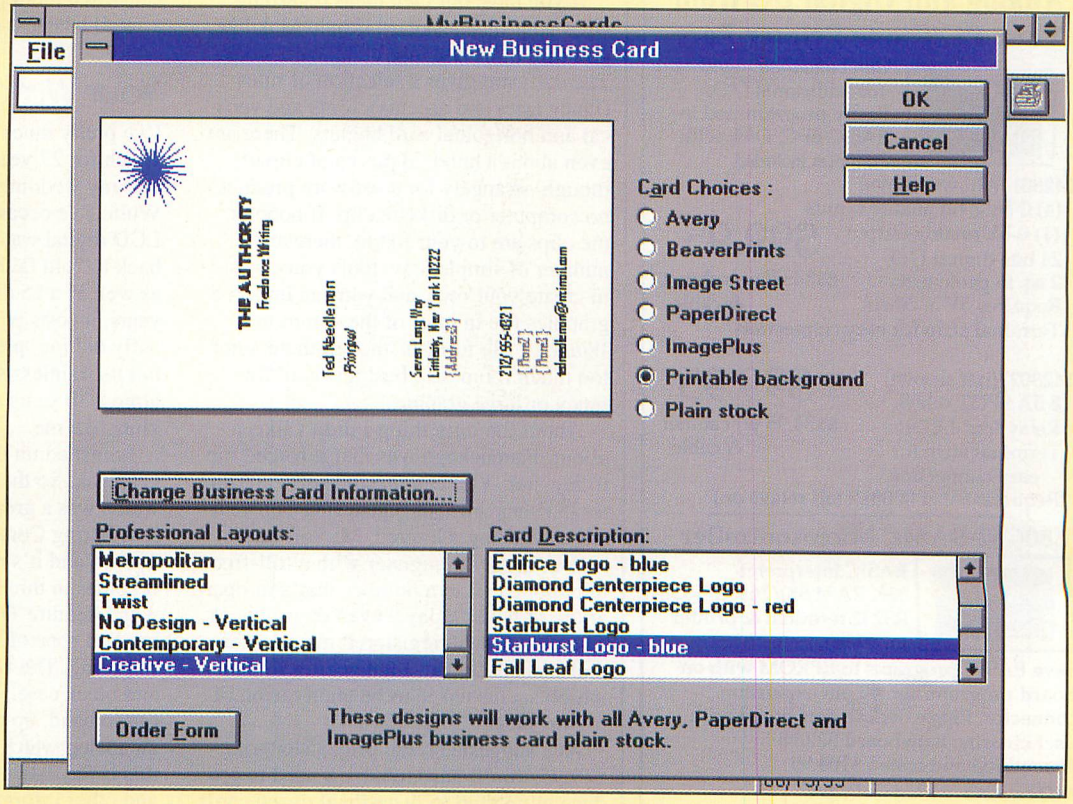
I have to state up front that My Software Company's My*Professional*BusinessCards is a piece of software that won't be attractive to a majority of readers. After all, unless you're Jim Rockford (from the old TV show "The Rockford Files"), how many times do you make up business cards? Rockford, if you don't remember (or never saw the show) was a PI who printed bogus business cards and used them whenever he didn't want to disclose his own identity.

Most of us are a bit more forthcoming about who we are. The problem with business cards, though, is that while you can get a bunch of them pretty cheap, they usually look just as chintzy. And if you want a custom look, the price goes way up. Either way, even at a quick print shop, getting cards made up takes from days to weeks. It doesn't much matter if you need only a few dozen cards. The real expense is in the setup. Buy 100 or 500, the price is pretty much the same.

With desktop publishing now such a big business, lots of the custom paper suppliers provide preprinted business-card stock. Also, many of the more-popular desktop-publishing packages provide a template for creating business cards. With a bit of perseverance, you can even set up most word processors to produce a pretty slick card. But it takes a whole lot more work to accomplish than many of us reasonably want to spend on such a project. An easier way is with an inexpensive software package created and optimized specifically for producing business cards, like My*Professional*BusinessCards.

Running under *Windows* and installing from two disks, My*Professional*BusinessCards includes direct support for more than 70 preprinted business-card designs available from vendors like Paper Direct, Avery, Beaver Prints, Image Street and Imageplus.

When you start the software and specify a new card, the program prompts you for the name that is to appear on the card, a title, company name, address, telephone number and e-mail address. Then you just key in the vendor and design number (or select it from a pick list), and the design is displayed on-screen with the information filled in where it belongs. Save the card, insert some of the proper card



Selection screen from *MyProfessionalBusinessCards*.

Timex and Microsoft teamed up to produce the amazing Timex Data Link watch that uses a PC's video monitor to download data to the Watch.

stock, and you're ready to print your cards.

MySoftware even includes samples from the various vendors. The box proclaims "Enough for 200 business cards," but you have to realize that there's only one page of card stock for a particular design. Unless you're going to continuously change designs on every page, you can't possibly use all of these "free" samples in the real world.

If you have our own ideas regarding what your business card should look like, you can, of course, use blank card stock. The software gives a selection of rules (fancy lines and accents), fonts and vertical and horizontal card layouts. There are even about a hundred pieces of clipart, though, strangely for a software product, no computer or diskette clip. If none of the clips are to your liking, there are a number of simple draw tools you can use to create your own, and you can import a graphics file in most of the common *Windows* file formats, though there's not too much room on a business card for fancy or large graphics.

About the only thing I didn't like about this package was that it forced me to register. You can use the software up to 25 times without registering before it stops working. Granted, MySoftware makes it easy to register with a toll-free telephone call to a number that's in operation 24 hours a day, seven days a week. The person who registered me was cordial and quick. But I hate being forced, which seems to me to be an invasion of my privacy.

At a suggested retail price (SRP) of $49.95, you'll have to have a need to produce more than an occasional dozen cards. But if you like to switch frequently between designs, have frequent temporary personnel working for you or just want the freedom of on-demand card production, you'll find My*Professional*BusinessCards easy (and even fun) to use. If your needs are somewhat more complex, you might want to look at My Software's *My Advanced Brochures*. This product supplements the business-card templates with brochure templates, letterhead and envelope templates and many more. At $99 suggested retail price, it's a great value for a small business or home office.

Your Watch is Talking

I've pretty much been wearing the same watch for 27 years. My Rolex Oysterdate was my wedding present from my wife. While I've occasionally had my LED and LCD digital watch flings, I always come back to "old faithful." It's never kept time as well as a $5 digital, and every few years, it costs twice what the watch originally did for "preventative maintenance," but its stainless-steel case has absorbed almost 30 years of use and abuse from a klutz like me.

I must admit that I'm an inveterate gadget freak. So the new Timex Data Link watch was a great temptation when I saw it at Spring Comdex. A quick call to Timex, and it's now residing on my wrist. It comes in three case versions, all of which feature Timex's Indiglo back lighting and none of which are particularly imposing. The watch I received has a gray and black case, with a tan suede and green fabric band. up where the 12 would be on an analog watch is a small "eye." Below this is the data panel that displays the time and other information.

Information is what this watch is all

A PERSONAL

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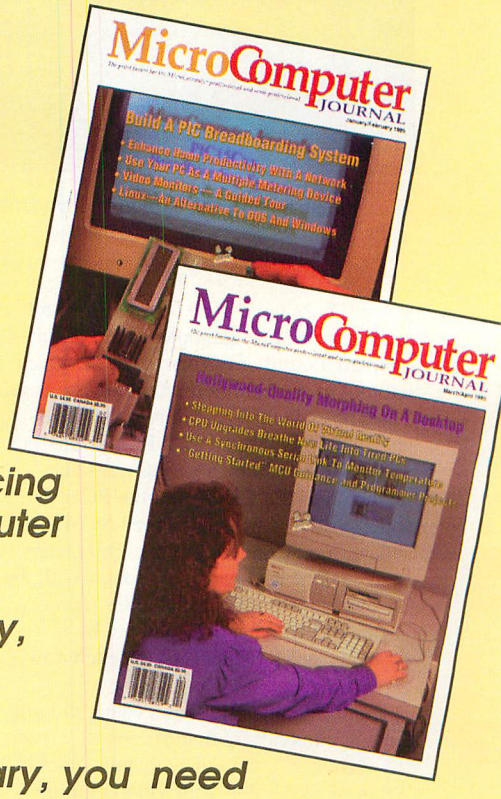

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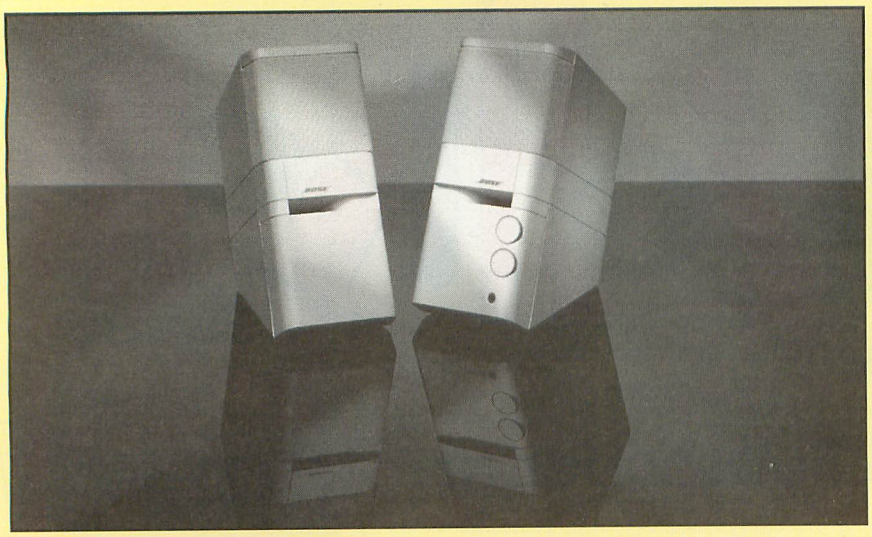


Bose packs high-quality sound into tiny, moderately priced speakers.

about. There have been other data watches, of course. For example, Casio has attempted a number of them over the years without experiencing tremendous success. The Timex is different in two major respects. It interfaces with a PC to transfer telephone numbers, appointments and memos into the watch, and the PC software to do this was developed by Microsoft. In fact, rumor has it that Bill Gates wears a Timex Data Link, though with the watch's approximately 70-entry memory limit and Bill's hectic schedule, he'd probably need a Data Link on each arm and both legs.

Running under *Windows* (what did you expect, considering that Microsoft wrote the software?), the utility installs quickly. After checking that your video monitor can transmit to the watch (you put the watch in calibration mode, point it at the monitor from a couple of inches away and wait for it to beep), the software lets you enter appointments, anniversaries, telephone numbers, time settings (you can be running two time zones simultaneously, and switch back and forth as needed), a to-do list and an alarm mode.

The software is nothing fancy, but it's easy to use and gets the job done. I transferred my telephone list from *Lotus Organizer* by exporting it from Lotus as a comma-delimited file and importing it into the Timex utility. The only problem I had was with the 70-item memory capacity. Because my telephone list is huge, I had to delete entries until I had just the bare minimum.

I had one other strange problem with the Data Link. When I first tried to install the *Windows* utility, I kept experiencing a GPF (General Protect Fault) error that locked up my machine. A quick call to the toll-free support line provided the answer. The software doesn't run under *Windows NT* or *Windows 95*. Considering that Microsoft wrote the software, this seems a bit strange.

Once I installed the software on a system running *Windows for Workgroups*, I was up and running in minutes. I love pointing my watch at my PC's video monitor and having data transmitted by a series of flashing bars on the screen.

Will the Timex Data Link be the watch that finally displaces the Rolex in my affections? Probably not. The Oysterdate and I have been through an awful lot over the years. But if I was looking for a watch to give as a present, the Timex would sure be a great choice. It lists at $130, but I've seen it for as little as $79 on sale. If you're a gadget freak like me, check out this watch! You're gonna love it.

Say Cheese

Building impressive graphic and multimedia presentations these days has gotten a lot easier with the terrific tools that have become available in the last couple of years. Figuring what to put in them hasn't, though. As more and more people are using software to jazz up their presentations, it has become a lot more important that your graphics look as good as they can. And if you're as artistically challenged, as I am, this means large collections of clipart, backgrounds and stock photos. Thankfully, lots of these are becoming available at very reasonable prices.

Corel has a big piece of this market, with its huge collection of photo CD-ROMs available for about $15 per CD. I've been playing with the new *Gallery 2* and will be covering it in a future column. If your pockets are deep enough, for about $700 or so, you can mail-order the complete Corel CD-ROM set, which consists of a whopping 200 CD-ROMs!

For those of you who need a nice selection of stock photos but don't have quite as large a budget, you might want to check out the new KPT Power*Photos* collection from HSC Software. HSC is a familiar name to anyone who works with computer graphics. This is the company that developed the fantastic *Kai's Power Tools*, a set of plug-in filters and tools for image-processing software like Adobe *PhotoShop* and Micrografx *Picture Publisher*. HSC has other cool programs, including a morphing package and the new *Convolver* that lets you really experiment with effects in real time. When HSC does a graphics product, it does it right!

Power*Photos* reflects this. Lots of photo collections are currently available, some for considerably less money than HSC's suggested $199 list (though the company is running a limited-time special for $99 that may still be available when this review appears in print).

The greatest difference between the "bargain" photos and Power*Photos* is the quality HSC offers. All 500 of the photos in this collection were shot specifically for this CD-ROM collection and digitized by HSC. Unlike some of the other collections I've seen, the photos are specifically geared to being manipulated digitally. Each image is in RGB TIFF format and in very high resolution, averaging between 18M and 24M apiece.

If you're familiar with the channel tools offered by *PhotoShop* and *Picture Publisher*, HSC has already built the channels into many of the photos, which will save hours of work. The 11 CD-ROMs are in dual format (*Windows* and Mac) and include Kodak's Browser software.

Power*Photos* is a five-volume set that contains 100 images that are centered around a series of themes. Because many presentations and images are built up from textures, the first of the five themes is natural backgrounds and textures. These contain images of different types of stones, paper, leaves, seashells, fabrics and the like. The second volume contains pictures of food. Again, because each picture is an object, it can be easily incorporated into another picture.

Urban Textures and Backgrounds; Sky, Water and Landscapes; and Sports and Recreation make up the final three volumes in the set. Conspicuously missing from this set are pictures of people and places. I'm sure that if this first volume is successful, HSC will follow it up with a variety of different image sets.

Not everyone needs photo collections

like HSC's PowerPhotos. But if you do, and the subject matter of the collection is something you can use, you can't go wrong with this one.

Sound of Music

If you know anything about high-end audio, you know the name Bose. Founded in 1964, Bose is legendary for developing tiny speakers that produce sound quality that rivals the best available. If you have a luxury car, it probably came with a Bose sound system as standard equipment. It was just a matter of time before this premium sound provider decided to enter the burgeoning computer speaker market.

The Acoustimass and MediaMate systems are Bose's first two entries. I didn't review the Acoustimass. A three-piece system employing a subwoofer, its $699 retail price puts it out of reach for the casual business user. You have to really need the highest-quality sound to justify this kind of outlay.

At a suggested retail price of $339, Bose's two-piece MediaMate setup can also hardly be considered inexpensive. But for speakers that measure only 7.4" high by 3.3" wide and 8.3" deep, the quality and volume of sound they pump out are simply jaw-dropping. With an A-B mixer on the Master speaker, it can easily combine inputs from two sources, such as a sound card and possibly a CD-Player. A headphone jack lets you listen quietly when necessary.

At this price, you're likely not going to buy these speakers to play games. *Doom* and *Descent* sound better on a three-piece subwoofer system like the Yamaha I reviewed here in the past or the Labtec system I'll be covering in the near future. As terrific as the bass is from Bose's tiny boxes, they simply can't produce the booming bass of a subwoofer. This is why Bose makes the high-end Acoustimass.

For the business user who needs really high-quality sound production, it doesn't get much better than this. In fact, this is the first speaker system I've come across that I feel could really be used to show the difference between different brands of sound cards—it's that good. Additionally, the Bose MediaMate is small enough and lightweight enough to easily go on the road. If you frequently travel to give multimedia presentations, take a good look at the MediaMate. It's fairly expensive, but it's well worth it. ■

Products Mentioned

MyProfessionalBusinessCards; $49.96
MySoftware Co.
1259 El Camino Real, Ste. 167
Menlo Park, CA 95025-4298
Tel.: 1-800-325-3508
CIRCLE NO. 145 ON FREE INFORMATION CARD

Data Link Watch; $130
Timex Corp.
PO Box 310
Middlebury, CT 06762
Tel.: 203-573-5764
CIRCLE NO. 146 ON FREE INFORMATION CARD

KPT Power Photos; $199; $99 Limited Time Offer
HSC Software
6303 Carpinteria Ave.
Carpinteria, CA 93013
Tel.: 805-566-6200
CIRCLE NO. 147 ON FREE INFORMATION CARD

MediaMate Computer Speakers; $339
Bose Corp.
The Mountain
Framingham, MA 01701-9168
Tel.: 1-800-444-BOSE
CIRCLE NO. 148 ON FREE INFORMATION CARD

By Tom Benford

Multimedia

Convert MIDI Files into .WAV Files, Sound/Audio Editing Software, a Humongous Photo Gallery on CD-ROM...and More

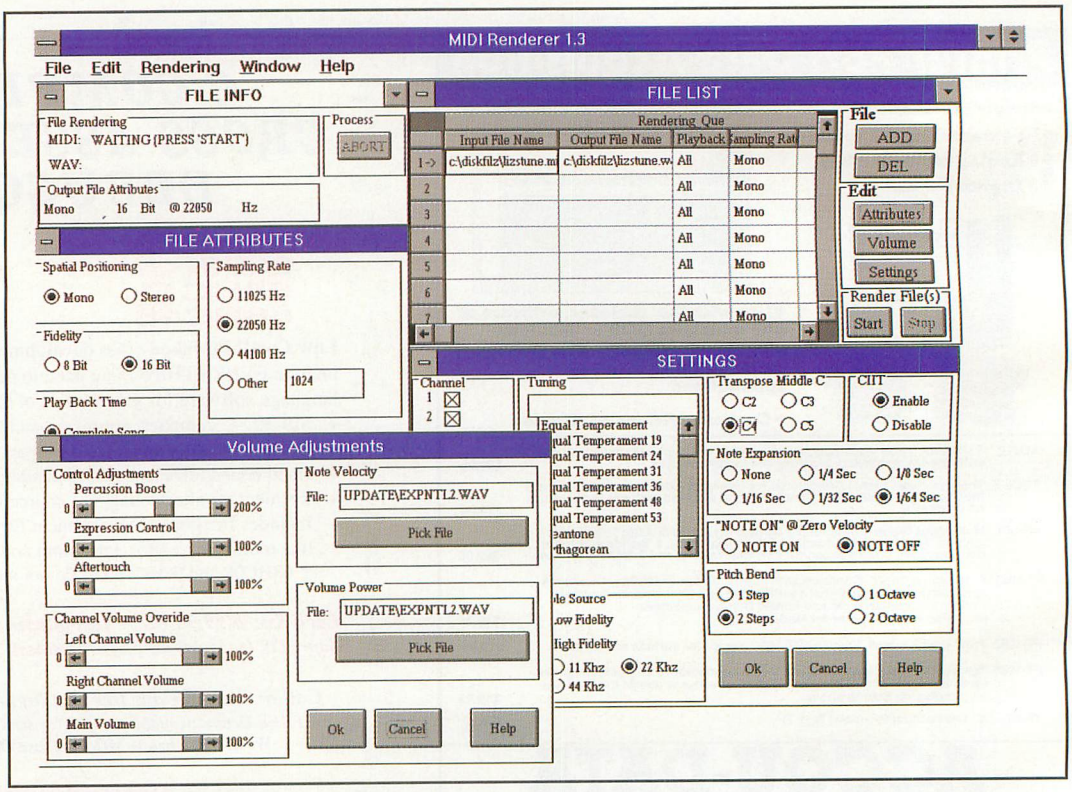
Many interesting multimedia items to delight both the eyes and the ears abound this time around. I begin with a CD-ROM-based program that converts MIDI files into .WAV files, a super sound/audio editing package, and then move on to a CD-ROM that's literally out of this world, Corel's 20,000-image photo library on CD-ROM, a sneak preview of the CD-ROM included with my new book, and more for your enjoyment. So, I'll jump right in.

MIDI Renderer

Most currently available sound cards are perfectly adequate for recording and playing back .WAV files and sound effects. However, due to their voice limitations, particularly with cards that employ FM synthesis, they usually do only a minimal job in playing back MIDI files. The solution for users who are serious about MIDI has traditionally been to purchase and connect an external tone generator or synthesizer to the sound card's MIDI port to expand their aural horizons. But the folks at DiAcoustics have now presented PC users who wish to explore the world of MIDI with another alternative. *MIDI Renderer* is a software package that permits you to create digital audio files from MIDI files.

In short, *MIDI Renderer* is a software synthesizer capable of producing CD-quality digital sound from standard MIDI files. The program comes with a predefined set of defaults that require no adjustment or modification to achieve outstanding performance right out of the box. It also offers a plethora of modifiable features to tailor the output specifically for your own needs or tastes. You can also play "what-if" by changing the voicing to hear what different arrangements of the same file sound like.

Perhaps the greatest strength of the program is that it permits you to play 128 simultaneous notes, each of which can be assigned to different instruments, if desired. Even the most-exotic and ambitious MIDI hardware setup that costs several thousands of dollars would be hard pressed to equal this



In main and subordinate screens of *MIDI Renderer*, in addition to pre-defined default settings, you can modify and alter output parameters to suit individual tastes or requirements by changing voicing, spatial placement, sampling rate/size, volume and more. It's possible to obtain CD-quality sound from an existing audio card, since the program creates digital audio files from MIDI files for playback on FM, non-FM and wavetable-based sound cards.

capability. The result is full orchestral capability. And, since you're no longer constrained by the limitations of your sound card, you can reproduce a grand piano that really sounds like a Steinway or any set of jamming drums.

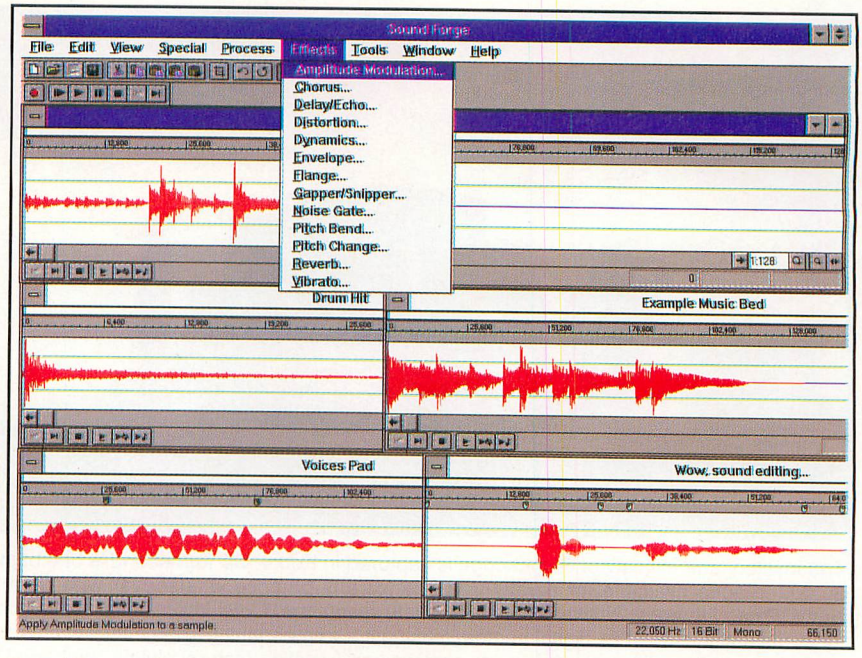
In addition to the obvious advantages of obtaining the sound of expensive MIDI synths or tone generators without having to purchase, install or use such hardware, *MIDI Renderer* is a boon to anyone who develops multimedia soundtracks using MIDI. Owing to the variety of sound cards in use, the quality of MIDI-file playback can vary greatly from card to card; by converting MIDI files into .WAV files, the audio will sound the same when played back, regardless of the sound card being used.

I should note that *MIDI Renderer* isn't a sequencing or composing software application. It can't and won't create a MIDI file for you. To be able to do this, you must use a dedicated application package that's capable of generating a MIDI file, such as *Cakewalk*, *Pro VI* or whatever your favorite MIDI sequencing package might be.

Once you've produced a MIDI sequence, you're ready to load the *MIDI Renderer* software. The program itself is supplied on three 3½" diskettes, and the actual instrument samples are contained on the supplied CD-ROM. You must have the CD-ROM in the drive to use the program, since it can't generate a .WAV file from your MIDI sequence without the sampled sound library.

All that remains to be done is to select your MIDI sequence(s) for conversion, either accept the default file-generation settings or modify them as desired and click on the start button. Several factors affect how long .WAV-file generation will take, including the number of MIDI tracks in the sequence, length of the MIDI sequence and output format of the generated .WAV file. For example, a MIDI sequence with eight tracks will take longer than one with only four tracks, a 4-minute song will take longer than a 2-minute one, and output in 44.1-kHz and 16-bit stereo will take longer to generate than 11-kHz, eight-bit mono.

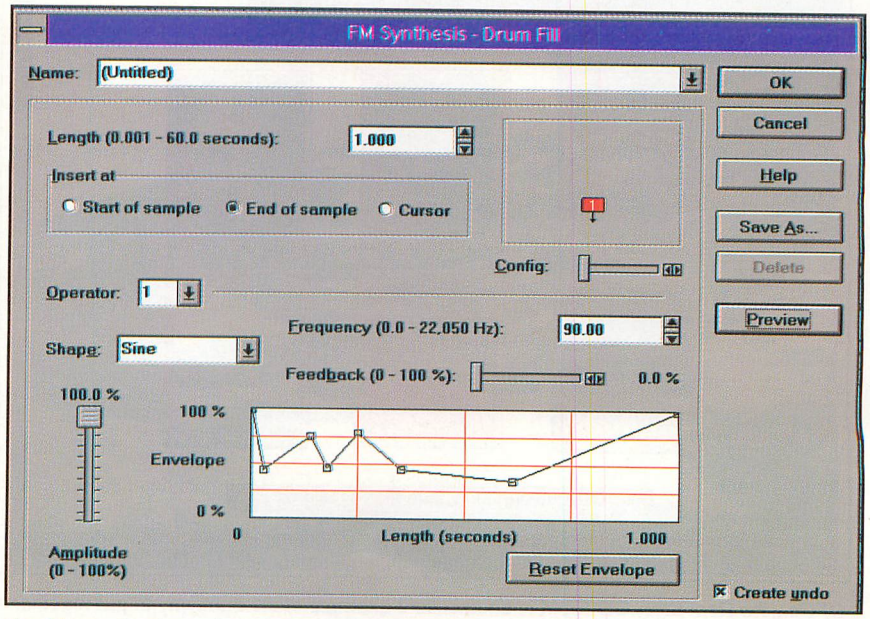
I've used the program almost exclusively from *Windows*, but it can also be used under DOS and OS/2 (versions for which are also included in the package), if you prefer. File generation is a bit quicker under DOS, as opposed to *Windows*, although everything has to be entered from the command line. Since I prefer using *MIDI Renderer* under *Windows* because of the extra convenience and graphical reminders it provides, I don't mind the extra minute or two it might take to generate a .WAV file from a sequence.



Sound Forge 3.0 improves on the solid features that made *Forge* 2.0 a strong package and adds several new capabilities that truly make it an "industrial-strength" audio program for professional and home studios. An impressive array of effects and processing options are available for "massaging" sound files into the exact form you want them. Multiple-window support makes it easy to work on several files simultaneously, and an extensive range of file import/export formats supported is second to none.

The program is fully-compatible with the General MIDI specification for drum-set and instrument sounds, and it includes all 128 GM instruments and percussion (drum-set) voicing. Up to 128 simultaneous notes and instruments can be played (polyphony and multitimbral), and it responds to all 16 MIDI channels and 128 tracks. Standard audio rates include 48, 44, 22, 11 kHz and user-programmable audio rates in eight- and 16-bit monophonic and stereo digital audio. The program supports both Format 0 and Format 1 MIDI file types. So you have just about everything you could wish for here.

MIDI-command support includes dynamic voice allocation, velocity response, modulation wheel, pitch bend,

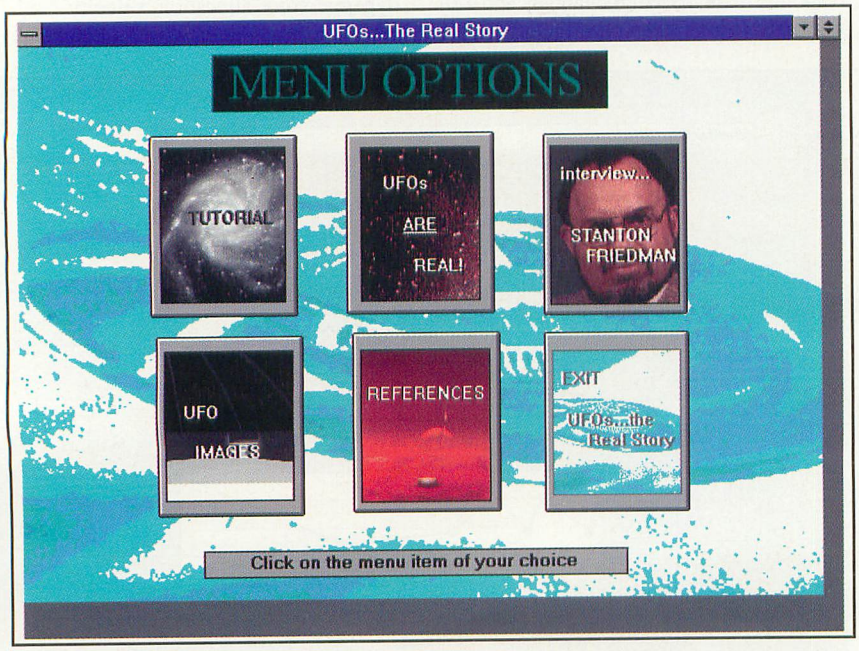


The FM synthesis engine in *Sound Forge* 3.0 gives you the ability to literally create sounds from scratch. You have complete control over the waveform, including shape, frequency, envelope, amplitude, feedback and other characteristics of sound.

The mystery and majesty of Stonehenge is captured in Kodak CD format and is one of the 20,000 images available for royalty-free use for any purpose whatsoever with Corel's *Stock Photo Library 2*. Unlike other stock-photo resources, Corel imposes no restrictions for commercial uses of its digital photos, making it a tremendous resource for advertising, marketing, multimedia and other such applications in which high-resolution, high-quality imagery is required.

aftertouch control, sustain pedal, expression control, volume control and pan stereo field. Multiple synthesis techniques are also supported, including additive synthesis, frequency-modulation synthesis, sampling, composite synthesis, re-synthesis, wave sequencing and physical modeling. Also supported is a user-programmable tuning system that includes Pythagorean tuning, Pythagorean comma, mean-tone tuning, quarter-comma mean-tone, golden mean ratio (1.618) and equal-temperament.

MIDI Renderer is a very nice package that's easy to use, exceptionally flexible and incredibly handy for anyone who is looking for a fast, efficient and reliable means of converting MIDI sequences into .WAV files without having to do any re-recording. It's a well-designed package that does everything it promises and more —and it does it well, to boot!



UFOs...the Real Story CD-ROM is an excellent example of the right way to put together a multimedia application using Multimedia Toolbook. The program is easily navigated by clicking on action-button icons that are linked to corresponding sections of program. Intelligently laid out, the disc is a fascinating resource on subject of UFOlogy.

Sound Forge 3.0

Sonic Foundry's *Sound Forge* 2.0 was a standard software tool I used very frequently until recently in my various music, audio and multimedia editing and production applications. As good as *Sound Forge* 2.0 was, in truth, I stopped using it because I found something much, much better—*Sound Forge* 3.0.

Some of the features that made *Sound Forge* 2.0 a long-time favorite with me were its ability to import and export myriad varieties of audio file formats, being able to work on several sound files simultaneously in separate windows and a dizzying array of special effects that could be used to alter a sound file in all sorts of marvelous ways. *Sound Forge* 3.0 has retained all of these impressive features and, in most areas, augmented them substantially.

Sound Forge 3.0 comes in two versions —16-bit for *Windows* 3.1 and 3.11 users, and a 32-bit version is also optionally available for users of *Windows NT* 3.1 or later (3.5 recommended), *Windows 95* Final Beta (final release recommended) or Microsoft Win32s Version 1.2 or later running on *Windows* 3.1 or later (Win32s is included on the *Sound Forge* setup disks).

The 16-bit version carries a suggested retail of $495, and the combo pack that includes both the 16- and 32-bit versions is $100 additional. I've restricted my use of *Sound Forge* 3.0 to the 16-bit version, since I need a stable platform for my applications and I don't have too much confidence in *Windows 95* at this point in time. Since the Win32s extensions have caused me problems in the past with some of my other applications, I'd rather play it safe than sorry.

An insert in the combo package advises that, depending on the 32-bit *Windows* operating system on which you're running the 32-bit version of *Sound Forge* 3.0, some limitations may be present. The insert states that "these limitations result from a lack of compatible hardware and software available for 32-bit *Windows* or are a direct result of the 32-bit *Windows* Operating System implementation." This caveat was enough to confirm that I'd made the correct decision to stay with the 16-bit version, at least for the present time.

Notable new capabilities the program has been endowed with are principally multiple links to the outside world that make it an ideal choice for use in the professional or home audio studio, and this includes MIDI devotees as well. *Sound*

Table 1. Categories on Corel's *Stock Photo Library 2*

Acadian Nova Scotia
African Birds
Air Force
Alps in Spring
Amateur Sports
Antique Postcards
Arthropods
Artist Textures
Asian Wildlife
Autumn In Maine
Aviation Photography II
Barbecue & Salads
Bark Textures
Beaches
Beautiful Bali
Beautiful Women
Belgium & Luxembourg
Berlin; Beverages
Bhutan
Bobsledding
Bonsai & Penjing
Botanical Prints
British Motor Collection
Canada
Canada, An Aerial View
Canadian Farming
Canadian National Parks
Canadian Rockies
Canoeing Adventure
Car Racing
Castles
Cats & Kittens
Caverns
Chicago
Classic Antarctica
Classic Aviation
Clouds
Colorado Plateau
Coast of Norway
Colors & Textures
Colors of Autumn
Construction
Copenhagen, Denmark
Cowboys
Creative Crystals
Creative Textures
Cuisine
Decorated Pumpkins
Desserts
Devon, England
Dog Sledding
Dolphins & Whales
English Countryside
English Pub Signs
Everglades
Everyday Objects
Exotic Hong Kong
Exploring France
Fabulous Fruit
Fashion
Fire Fighting
Fish
Fitness
Flowers Close-Up
Foliage Backgrounds
Freestyle Skiing
Frost Textures
Fruits & Nuts
Fungi
Garden Ornaments & Architecture
Gardens of Europe
Greek Scenery
Highway & Street Signs
Hiking
Historic Virginia
Holiday Sheet Music
Horses in Action
Hot Air Balloons
Hunting
Images of Egypt
Industry & Transportation
Interior Design
International Fireworks
Ireland II
Jamaica
Japanese Gardens
Java
Jersey Channel Islands
Kenya
Kitchens & Bathrooms
Lake District, England
Landscape Backgrounds
Landscapes of the World
Light Textures
London, England
Lost Civilizations
Lost Tribes
Marble Textures
Martial Arts
Masters I
Masters II
Masters III
Masters IV
Mediterranean Cruise
Mexican Holiday
Middle East
Military Aircraft
Montreal
Morocco
Mountains of Eurasia
Namibia
Nature's Textures
Navy SEALs
Nepal
Netherlands
New Guinea
New York, New York
Night Scenes
North American People
Northern Wilderness
Northwest Africa
The Oregon Trail
Painted Textures
Paris
People II
Performance Cars
Picturesque Paris
Polo
Portrait of Alaska
Portugal's Countryside
Prague
Prince Edward Island
Quebec
Rafting
Rainy Nights
Recreational Sports
Reflections
Reflective Effects
Rocks & Gems
Rodeo
Romance of France
Royal Military Parades
Rural England
Russia
Rustic Quebec
Sailboarding
Sailing
Sand & Pebble Textures
Scenic Austria
Scenic Japan
Scenics
Shakespeare's Country
Sheet Music Cover Girls
Shell Textures
Sierra Nevada Mountains
Sights of Africa
Solitude
Space
Space Scenes
Spectacular Waterfalls
Speedo Swimsuits
Spice & Herb Textures
Sports & Leisure
Spring
Steam Trains
Studio Models
Sunsets Around the World
Surfing
Sweden
Tall Ships
Textile Patterns
Textures by James Dawson
Textures II
Theater
Tools
Tour Through Europe
Trains
Trains of the World
Tropical Sea Life
Under the Red Sea
Underwater Photography
Utah, Color Country
Valley of Fire
Victorian Houses
Virgin Islands
Wading Birds
Washington, DC
Washington State
Water Sports
Waves
Weddings
Whitetail Deer
Wildcats
Wildlife Paintings
Women in Vogue
World Landmarks
Yemen
Zimbabwe
Zion National Park

Forge 3.0 now features an impressive FM-synthesis engine, MIDI triggers, time-code and external-sampler support.

If your audio editing needs are fairly basic, *Sound Forge* 3.0 will undoubtedly be overkill. On the other hand, if you're interested in doing some very ambitious sound editing and mixing, or you're producing multimedia audio, this is definitely a program you'll learn to love in a hurry. For example, the package is a special delight for those of us who use hardware samplers in our production work.

The program's Sampler Tool Plug-In allows you to transfer .WAV files between your PC and the sampling device (for example, a sampler keyboard) via MIDI Sample Dump Standard (SDS) or SCSI Musical Data Interchange (SMDI) if your sampler supports this protocol. The software is pre-configured for several popular samplers, and its flexibility is increased through a bunch of loop tuning controls.

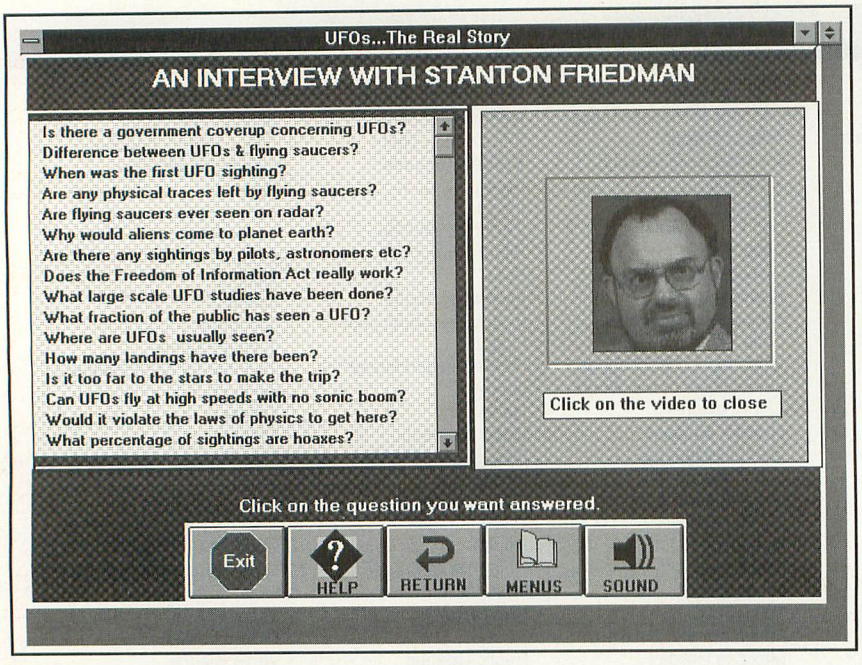
A really pleasant surprise and a very nice touch is the FM-synthesis-engine capability that provides four-operator FM using any of 13 different algorithms with adjustable, independent amplitude envelopes. Using the FM or simple additive synthesis, you can create various static waveforms that give you the ability to create sounds "from scratch" and transfer them to your sampler. With some imagination and practice, you can create entire sample libraries of new sounds—including some that are unlike anything you (or anyone else) has ever heard before.

Another really unique feature of *Sound Forge* 3.0 are the MIDI functions it incorporates. No other audio-editing program known to me provides any MIDI support. *Sound Forge* 3.0 can trigger playback of one or more sound files using MIDI-note messages, thus giving you the ability to trigger audio files from a sequencer or keyboard, as well as from a MIDI file itself. This is a very handy capability to have, especially for multimedia applications in which you might want a prerecorded .WAV narrative segment to play automatically when a certain point in the MIDI "theme" music is reached. Possible uses for this triggering ability are quite fertile. If this isn't enough by itself, the program also provides support for SMPTE and MTC triggering that gives additional flexibility and capabilities for precise synchronization of sound files to video.

For anyone creating, editing and producing audio using *Windows*, *Sound Forge* 3.0 is the ultimate tool that literally provides the power of a professional audio studio right on your PC. It's already become a work-a-day standard application and a most welcome addition to my own production studio.

Corel *Stock Photo Library 2*

PC and Mac users who are involved in multimedia, graphic arts, advertising or other applications in which access to a vast resource of high-resolution, royalty-free photographic images is needed will be happy to learn about Corel's *Stock Photo Library 2*. This is a collection of 20,000 photographs that come on 200 CD-ROMs (yes, you read that correctly, there are 200 discs in the set), all in Kodak Photo CD format.



The interactive nature of *UFOs...the Real Story* permits you to have a one-on-one interview with Stanton Friedman himself, in which he answers the most-frequently-asked questions regarding UFOs, government cover-up conspiracies, theories on interstellar travel and more.

As you may have surmised by the "*Library 2*" designation, this is Corel's second collection of 20,000 photographs (*Library 1* debuted in the Fall of 1994). Carrying a suggested U.S. list price of $995 ($1,295 Canadian), the price per photo works out to less than 5 cents each, making it one of the most spectacular image-resource deals of the century.

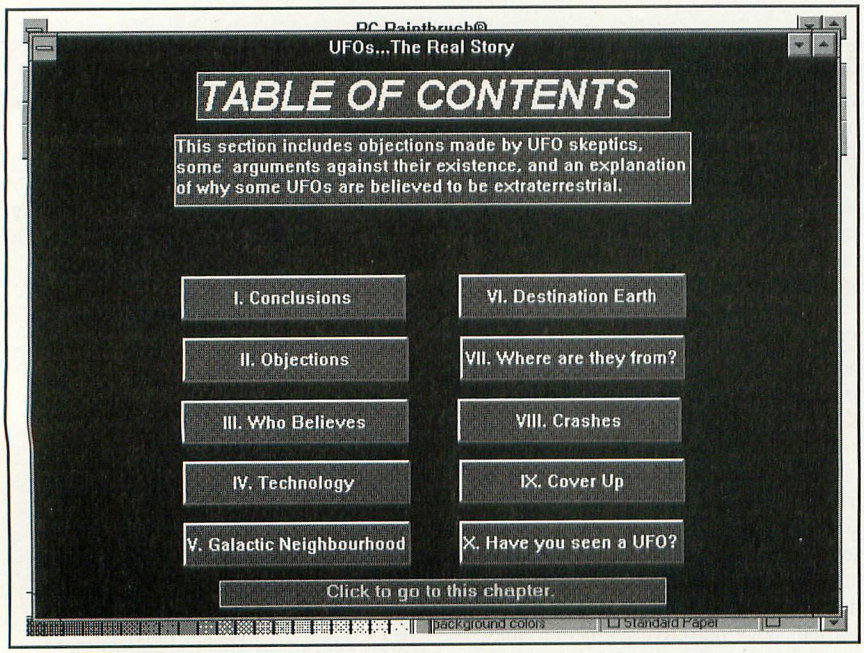
What types of photos are contained on the discs? Perhaps you should ask what's not included. Table 1 contains a listing of the categories, arranged alphabetically.

Corel also provides its Visual Database software with the library, which permits searching for specific images from the 20,000 photographs available by entering up to four descriptive keywords. Additionally, a full-color reference manual that shows all 20,000 photos is provided.

Other comprehensive utility programs provided with the library include Corel's Photo CD Lab that lets you manipulate the size, color, resolution, orientation and file format of each photo, in addition to creating slide shows and building catalogs of photo images. Corel's Mosaic Visual File Manager is provided for organizing and managing images, and Corel's Artview Screen Saver permits using all of the *Professional Photo* titles discs to be used as screen savers. Corel's CD Audio player, Wallpaper utility for exporting the photos as *Windows* wallpaper and the Wallpaper Flipper utility to change wallpaper automatically every time *Windows* is started completes the software utility suite.

Like a Ginsu knife commercial, there's more! As an extra special bonus Corel includes *The World's Best Digital Photographs* coffee-table book and CD-ROM with the *Library 2* package.

Since all images are in Kodak Photo CD format, they can be used on Macintosh computers, as well as *Windows* PCs and can be read by any CD-ROM drive (XA support isn't required). Regardless of what your image needs are, chances are excellent that you'll find exactly what you're looking for in Corel's *Stock Photo Library 2*.



The table of contents screen for the disc exemplifies excellent design of the *UFOs...the Real Story* CD-ROM. Access to all program components—text, photo, audio, video—is accomplished by clicking on an action button to bring you directly to the topic or area desired. Photos and videos are sharp, and audio is clear.

UFOs. . .the Real Story CD-ROM

With the incredible popularity of such television series as The "X Files" and "Encounters," the subject of UFOs and the entire subject of extraterrestrial phenomena is a natural—and ripe—one for CD-ROM. This is the conclusion Unity Publishing evidently came to when it produced and released its CD-ROM dealing with this subject.

Unity Publishing, in partnership with Stanton Friedman, nuclear physicist and famed UFO researcher, have teamed efforts in producing this interactive CD-ROM that runs under *Windows*. Friedman, a well-known personality in the UFO world, has spoken at more than 600 colleges and a hundred professional groups around the world. Moreover, he has published 60 papers on UFO phenomena and co-authored the book "*Crash at Corona*," now in its fifth printing. Friedman has more than 36 years of investigation and study in this area to his credit, and, based on his experience and knowledge, you'd be hard-pressed to find a better-qualified authority on the subject of UFOlogy.

Authored under Asymetrix's Multime-

I greet you via the Intel Motion Video Player applet on the *Introducing Desktop Video* CD-ROM included with my book of the same title. Also included on-disc are 17 video segments (descriptive titles for some are visible in this illustration), including an original music video by me and one by rock star Iggy Pop. Also included are dozens of .WAV files, .DVP project files, components, software demos, video clips, bitmaps and lots of other goodies. The disc contains more than 45 minutes of video and illustrates techniques and step-by-step projects described in the book's text.

dia Toolbook, the CD-ROM examines the possible existence of extraterrestrial spacecraft, the viability of interstellar travel and our government's cover-ups of its involvement in UFO investigation.

Through eyewitness videos, rare photographs, previously classified top-secret documents and an interactive interview with Friedman himself, the program answers many of the questions people have about UFOs, challenging the claims that they can't exist.

A variety of topics from propulsion systems like nuclear rocket engines and electromagnetic submarines to acceleration and astronomical distances can be browsed by users in video, audio, text and hypertext links.

Numerous full-motion video segments are provided on the disc, including actual footage of UFOs in flight, interviews with Betty Hill, Travis Walton, Jesse Marcel, Sr., Jesse Marcel, Jr., and other notable personalities, events and physical evidence.

Several dozen still photographs, newspaper clippings and animations and scores of references are included and combine to make *UFOs...the Real Story* one of the richest information resources on the subject. Whether or not you believe we're being visited by extraterrestrials, *UFOs... the Real Story* is a fascinating, authoritative and exceptionally well-produced CD-ROM that's both informative and entertaining at the same time.

Introducing Desktop Video Book

At long last, my latest book, *Introducing Desktop Video*, is complete and on sale at better bookstores nationwide. I'm particularly happy with this work, which is my third book published by MIS:Press, since it's literally a "ground-up" guide for anyone who is interested in doing desktop video, whether as only casual curiosity about what's involved in it or as the basis for serious production uses.

In writing this book, I combined and distilled the knowledge and practical experience I've gained over the last 25 years from my independent film making, videography and multimedia production work to present a hands-on approach to integrating all types of media elements—music, video, graphics, titles, sound effects, animation graphics, even home movies—into desktop video productions.

Among the topics I cover in the book's 11 chapters and three appendices spanning 336 pages are: basic video concepts and terms; practical uses and reviews of some popular software programs; equipment recommendations for producing better video footage; special effects like morphing; planning a production from concept

to final presentation and full, detailed explanations on creating production logo "sigs," "tag lines" and much more.

I start by explaining the differences between NTSC video and digital computer video, discuss what's involved in converting one to the other, go through the installation of a video-capture card and capture/editing software, explain compression, disk space requirements, special effects, titling, morphing, etc. I also give specific recommendations on selecting equipment and improving your video shooting techniques to obtain better source video footage prior to digitizing. Thanks to desktop video technology itself, I was able to produce and include the CD-ROM that demonstrates what you can do using the techniques and procedures I provide in the text. Also included in the CD-ROM are a runtime version of Microsoft's *Video for Windows* 1.1d and the Intel *Motion Video Player* applet to get you off to a flying start.

To keep the subject matter entertaining, I selected some "fun" topics for the videos, including a segment on Kildrummy The Wonder Dog giving tennis tips, a Steadicam JR demonstration, a point-of-view perspective video with a camcorder mounted on a radio-controlled model car, an interview with a person who lives in the UFO capital of the world, an original music video from my new *Progressions* CD album, Iggy Pop's *Beside You* music video and lots more. Some of the early reviewers have said that the content of the disc is worth the price of the book alone—who am I to disagree?

If you'd like a personalized copy of *Introducing Desktop Video* with the bonus CD-ROM included, you can order it directly from me at the address given in the "Products Mentioned" box (checks or money orders only, made payable to Tom Benford, please) and I'll be happy to inscribe it for you. I'm very pleased with it, and I think you will be, too. ■

Products Mentioned

MIDI Renderer, $129 for DOS, *Windows,* OS/2
DiAcoustics
555 Sparkman Dr., Ste. 600F
Huntsville, AL 35816
Tel.: 205-722-0490

CIRCLE NO. 140 ON FREE INFORMATION CARD

Sound Forge 3.0; $495, 16-Bit; $595, 16- & 32-Bit Versions
Sonic Foundry, Inc.
100 South Baldwin St., Ste. 204
Madison, WI 53703
Tel.: 608-256-3133

CIRCLE NO. 141 ON FREE INFORMATION CARD

Stock Photo Library 2, $995
Corel Corp.
The Corel Bldg.
1600 Carling Ave.
Ottawa, Ontario, Canada K1Z 8R7
Tel.: 613-728-3733

CIRCLE NO. 142 ON FREE INFORMATION CARD

UFOs...the Real Story CD-ROM, $39.95
Unity Publishing
106 Main St., Ste. 194
Houlton, ME 04730
Tel.: 800-704-3777

CIRCLE NO. 143 ON FREE INFORMATION CARD

Introducing Desktop Video Book & CD-ROM; $34.95 (Checks or Money Order Only)
Tom Benford
2329 Hwy, 34, Ste. 201
Manasquan, NJ 08736
Tel.: 908-223-2271

CIRCLE NO. 144 ON FREE INFORMATION CARD

Bits 'n' Pieces By Alexander W. Burawa *(from page 46)*

installed on your hard drive. When you select the OS you want to use, the system boots up in it. No fuss, no hassle.

If you want to change your operating environment at any time, exit the application you're using and re-boot your system. When the *System Commander* menu appears, simply select the desired OS from the choices available.

As you install new OSes, *System Commander* copies key files and adds the new additions to its selection menu so that they're immediately available the next time you boot your PC. When you make a selection from the menu, *System Commander* automatically vectors to the unique key hidden files, boot records and configuration files for the OS chosen and updates future changes.

Since *System Commander* uses no resident memory, it eliminates any possible clash between it and your OSes and other programs. It installs in the DOS partition but doesn't use DOS during boot-up. Furthermore, it has an uninstall utility to return your PC to its original state, if you desire this. It also provides boot-sector protection checks for virus infections and replaces infected boot sectors. Additionally, *System Commander* provides tamper-proof system security by protecting any and all of your operating systems, hard and floppy drives and setup menus from unauthorized access. The program doesn't require re-partitioning of your hard disk and doesn't require a partition of its own.

Laptop users who need different configuration files for portable use and for connecting to a network or docking station will find *System Commander* ideal for their purposes. On boot-up they can select the configuration needed for the conditions at the time.

System Commander even provides boot-sector protection checks for virus infections. If a virus is detected, it replaces the infected boot sectors at your command.

System Commander 2.09 works with any 8088 through 80486 and Pentium processor, MS/PC-DOS 3.0 and later, DR-DOS 5.0 and 6.0, Novell-DOS 7.0, Japanese DOS/V, *Windows* 3.1, Windows for Workgroups 3.1, *Windows 95*, *Windows NT* 3.1 and later, OS/2 1.x and later and any other Intel-compatible operating environment. It's also compatible with IDE, EIDE and SCSI drives of any size.

Product Information

System Commander 2.09, $99.95
V Communications
4320 Stevens Creek Blvd., Ste. 120
San Jose, CA 95129
Tel.: 408-296-4224; fax: 408-296-4441

CIRCLE NO. 171 ON FREE INFORMATION CARD

Microcomputer Q&A

By TJ Byers

In this column, I answer questions about all aspects of computer disciplines, both hardware and software, plus related electronics queries. You can reach me on America Online at TJBYERS on CompuServe or Internet at TJBYERS@aol.com or by mail at MicroComputer Journal, 76 N. Broadway, Hicksville, NY 11801.

Recycling CD-ROM Disks

Q. *I have a stack—and I do mean a stack—of CD-ROM disks that I no longer have use for. Is there anything I can do with them, other than donate them to the local landfill?*—J. Dove, via Internet.

A. First you have to cull though your CDs and sort them by color. CDs come in two colors, gold and silver. Like Olympic medals, gold is better than silver. About the only thing you can do with silver CD-ROM disks (music or computer) is to cut them into unique shapes and make a mobile out of them. The prism-like colors are striking when a breeze spins the platters. They also make pretty nifty Frisbees.

Gold-colored CDs, on the other hand, may be recyclable. If it's reusable, there will be a Compact Recordable label somewhere on the disk. Most 5¼" CD-ROMs hold about 650M of data, much of which often goes unused. So if you have a gold disk and CD-ROM recorder, you can probably add files to the disk.

Another use of a gold disk is to convert your color slides into digital files using the Kodak Multisession format. This isn't always possible, though, depending on the CD's original format, so check with your local camera shop or film processor before investing time and money.

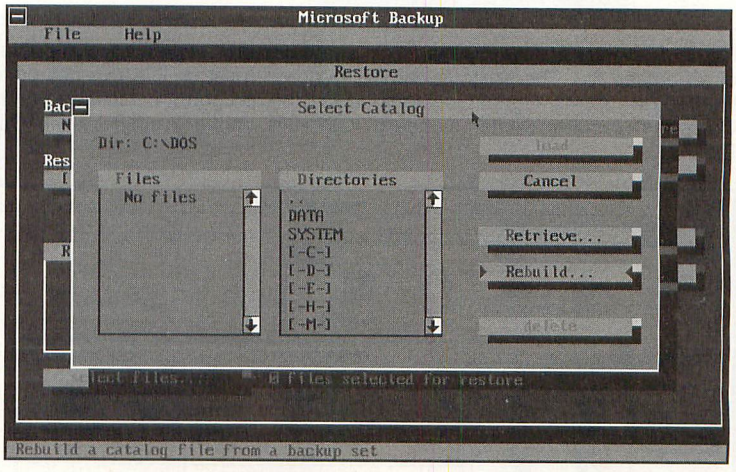


Fig. 1. If you lose your backup catalog file, you can reconstruct it from the backup disks or backup tape using the Rebuild option. This method works for all backup programs, including MS BACKUP for DOS and *Windows, Norton Backup* and *Central Point Backup* (PC Tools).

Are Recycled Inkjet Cartridges Safe?

Q. *I have an HP DeskJet 500 printer that goes through ink cartridges like nobody's business. At $25 a pop, the printer's voracious appetite for ink is getting pretty expensive. I received a catalog in the mail the other day that advertises inkjet cartridge refill kits for about $5 a refill. However, the printer manual warns against refilling the cartridge. I'm confused. Can the cartridge be refilled or not?*—J. Golomb, Brooklyn, NY

A. A call to the two leading makers of inkjet printers, HP and Canon, produced the same answer: They don't recommend it. This is because these refill kits use a syringe-like device to inject fresh ink. A sharp needle pierces the cartridge's bladder, and a plunger forces the ink into the cartridge. Both vendors cite the puncturing process as a potential leakage problem. Canon went on to further state that because of the built-in bubble-jet head, there's a chance a piece of dried-on ink could break loose and clog the nozzles in the same way blood clots cause strokes. My take on this, and I can see the letters pouring in already, is that refill companies wouldn't be in business for as long as they have if their products didn't work. But you have to use common sense when refilling old cartridges.

First, you *must* seal the puncture wound completely to prevent leakage. The Nu-kote kit from Globe (tel.: 800-845-6225) claims to do this automatically. Second, I wouldn't recommend filling an empty cartridge that has been rolling around in your desk drawer for six months because the old ink is dried out and could cause clotting problems. Finally, I wouldn't refill a cartridge more than twice for fear that it may become a leaky pincushion.

Lost Backup Catalog

Q. *I'd like to know if there is any way to recover a backup file if the original catalog listing file is gone?*—Pedlin, via America Online

A. Sure, this is an easy one, and it works for most backup programs, including MS-DOS MS BACKUP,

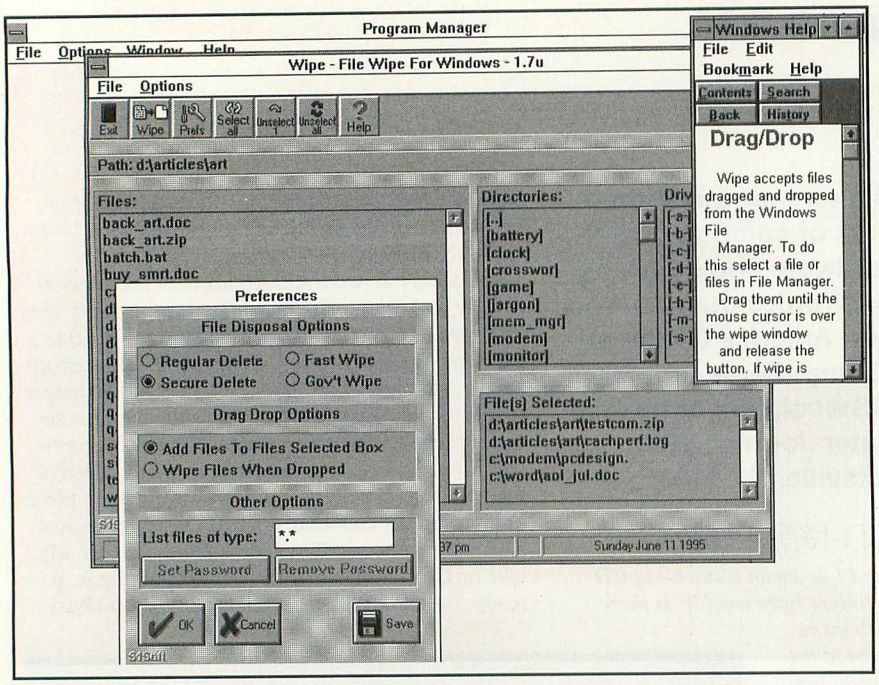


Fig. 2. *File Wipe for Windows* is a shareware security erase utility that prevents recovery of an erased file. The program can be found on most on-line services under the name WIPE17.ZIP. At its highest security level, the program complies with the National Computer Security Center standard (CSC-STD-005-85) used by the Department of Defense.

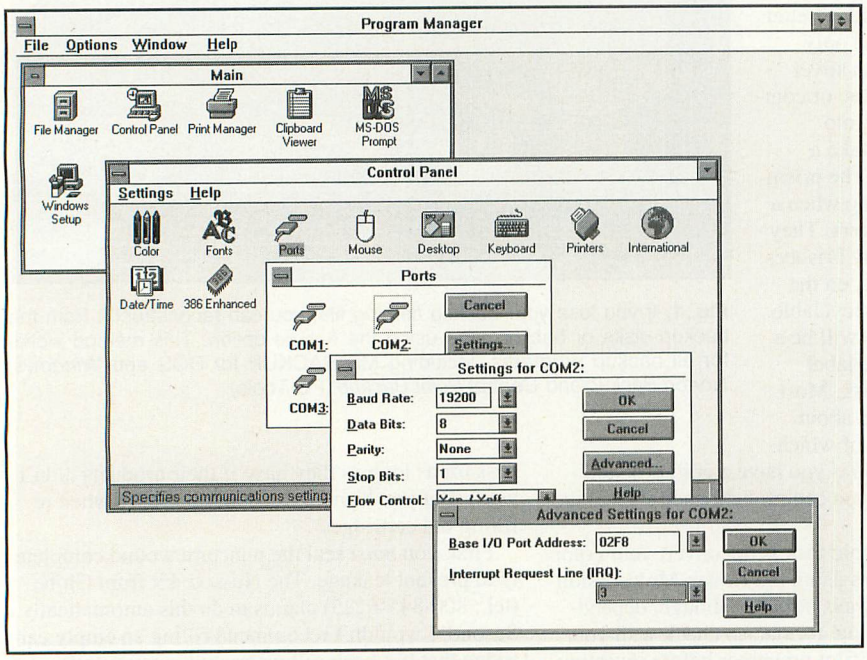


Fig. 3. *Windows* can't recognize COM ports that are out of sequence. For example, if COM1 and COM2 are in use and you set your modem to COM4, *Windows* will either report it as COM3 or fail to see the device at all. The cure is to make sure there are no gaps in the sequence by chaining the hardware accordingly and then running the port setup routine.

Norton Desktop and *PC Tools*. Simply put the first backup disk in your floppy drive and type in or click on the command that starts the backup process and rebuild the catalog. Here's how it works for DOS MS BACKUP.

If you're in *Windows*, quit it. At the DOS prompt, type MS BACKUP. Now insert your first backup diskette into the appropriate drive (A: or B:) and select the Retrieve command. Next, choose the Rebuild option located to the right of the screen (Fig. 1). The program will now read the name of the catalog on the diskette and enter it into a dialog box. Highlight the catalog name, load it, return to the Retrieve menu, ands select your files. That's it.

If, for some reason, one or more of your backup diskettes are missing or damaged, MS BACKUP will attempt to repair them or skip over the missing disks. By the way, you can also use this method to transfer files from one system to another.

Deleting Files Forever

Q. *Is there any way to permanently delete files and/ or directories so that no one can use UNDELETE to restore them?*—C. Benson, via Internet

A. These utilities go by the name of shredders, trash cans and security erase. Most desktop packages like *Norton Desktop* and *PC Tools* have one, as does *Windows 95*. You can also find shareware "shredder" utilities, like File Wipe for Windows (Fig. 2) in the public domain at low cost. When DOS or *Windows* "erases" a file, it simply deletes the first character of the filename from the directory, making it invisible. The file itself remains intact, which is why it's recoverable. A shredder utility not only erases the file name from the FAT, it also overwrites the entire file with garbage characters, like all 0s.

If your security needs aren't too demanding, you can write your own trash-can program. To recover an erased file, UNERASE has to locate the first sector of the file. If you overwrite the first sector with another file, even a small one, the chain is broken and the deleted file is virtually unrecoverable using standard recovery techniques. An easy way to do this is with a short batch file like:

```
ERASE %1
COPY C:\COMMAND.COM %1
ERASE %1
```

To create this program, type COPY CON SHRED.BAT at the DOS prompt, enter the above three lines (the indent isn't necessary) and press F6. To use the utility, type SHRED [filename]. For example, SHRED README.DOC. Just be aware that the seed file, COMMAND.COM, may be smaller than the file it's overwriting. Which means that there may be fragments of the file in scattered sectors on the disk that could be looked at using a sophisticated sector-reading program like that found in *Norton Utilities*, but it would take a lot of work and time. The file itself, though, can never be reconstructed.

System Halts

Q. *While using* Quicken, *I went to back up the file to my B: drive, only to get the message, "No ROM BASIC. System halted." I*

contacted Quicken *and the tech-support person didn't have a clue as to what caused the problem, but he said it might be a bad disk or memory problem. So which is it, and how do I fix it? It's happened only twice, but this is two times too many.*—Mike D., via America Online

A. The last time I saw this message, I was running IBM PC-DOS 3.1 on a 286 PC AT clone. In the heyday of the PC AT (1984 to 1987), the BIOS chip contained the BASIC-language program—or at least a portion of it, if you had an IBM original—that prevented the system from stalling if it couldn't locate DOS. The BASIC code has since been dropped from the BIOS, and the new error message reads "Insert disk with \COMMAND.COM in drive A. Press any key to continue..." What your warning message is saying is that, for some reason, the system can't find DOS, and is trying to start the BASIC program—which obviously doesn't exist in your BIOS. Generally this happens if you boot the system from a floppy, rather than your hard, disk and replace the boot disk with a data disk. If by some chance you booted the system from a floppy with a COMMAND.COM dated 1988 or earlier and then removed it from the A: drive, this could be your problem. Without knowing more about your system, though, I don't know what else could be causing it.

Modem Hangs Up

Q. *I'm trying to download some files from a local BBS, but my modem keeps hanging up right in the middle of the transfer. How can I get my modem to stop hanging?*—S. Wallace, via CompuServe

A. A couple things can cause this problem. For one, several bulletin boards have a time limit on how long you can stay on-line—usually about an hour per day. This is because they have only so many telephone lines and it would be unfair for a handful of users to hog them all. Generally, there's a message that tells you how much time you have left while working on-line. Another problem could be the lack of disk space or not enough open files. If you've reached the limit of files you can have open at one time, you need to modify your CONFIG.SYS file to make room for more. Using a text editor like EDIT, locate the FILES=xx line and increase the number shown by at least 25%. The maximum number of open files is 255, and the default is eight files. As a rule, 50 files is enough for most *Windows* work.

In The Market For a Modem

Q. *I recently subscribed to an Internet service and quickly discovered my old 2,400-baud modem just can't cut it. It takes much too much time to do even the simplest things. So I went shopping for a new modem, only to be bombarded with V-dot-this and V-dot-that terminology. What does it all mean, and which modem should I buy for use on the Internet?*—WISSEN, via Internet

A. The V-dots you refer to are communication standards established by the CCITT (Comite Consultatif International Telegraphique et Telephonique) for the universal exchange of data. Some V-dot numbers define a data rate and transmission protocol, while others specify error-correction methods or data compression. V.22*bis* was the first true world standard for data communication. It permits a transfer rate of 2,400 bps (bits per second) using phase modulation. Your old modem is undoubtedly V.22*bis*-compatible. The standards range from 1,200 to 28,800 bps. A chart of the CCITT standards is given in

Table 1.CCITT Modem Standards

CCITT Standard	Data Rate (bps)	Use
V.17	14,400	Fax Protocol
V.21	600	Data Protocol (Obsolete)
V.22	1,200	Data Protocol
V.22*bis*	2,400	Data Protocol
V.29	9,600	Fax Protocol
V.32	9,600	Data Protocol
V.32*bis*	14,400	Data Protocol
V.32*ter* or V.32*terbo*	19,200	Data Protocol
V.fast	28,800	Data Protocol
V.34	28,800	Data Protocol
V.42	N.A.	Error Correction
V.42*bis*	N.A.	Data Compression
Bell 212/103	1,200/300	AT&T Standards (Obsolete)

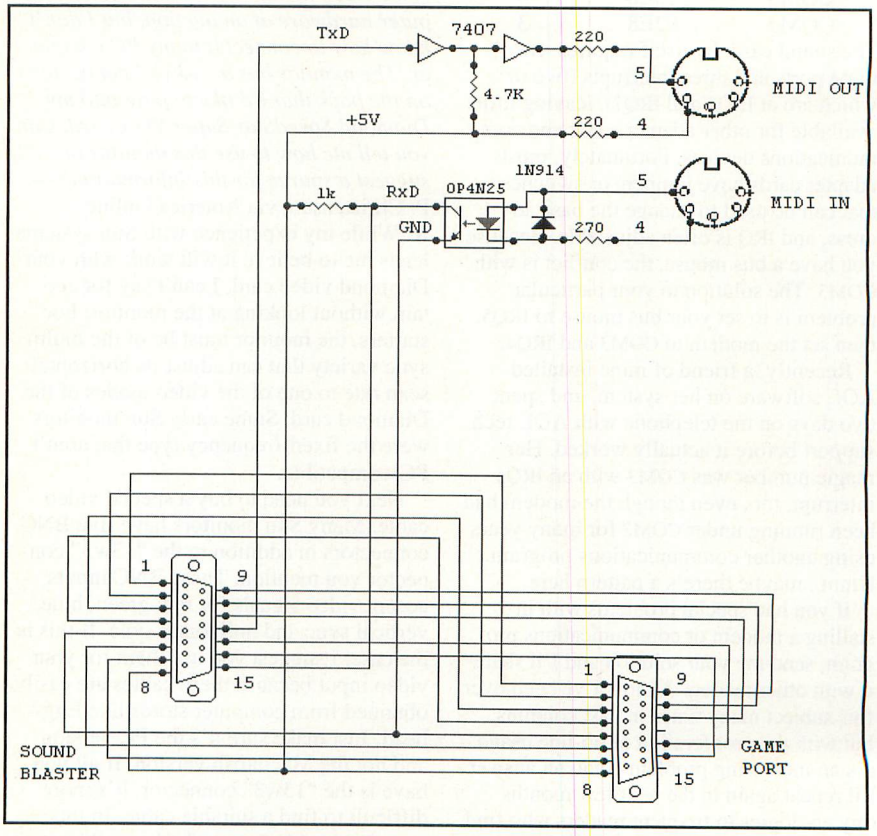


Fig. 4. To make a SoundBlaster MIDI/ game port adapter, you need two five-pin DIN connectors (one plug and one jack) and two 15-pin D-sub connectors (one male and one female) wired as shown. The optional circuitry is included to isolate the SoundBlaster port from the MIDI port, and it's highly recommended that you include it. If you don't want to isolate the interface, wire the TxD and RxD lines directly to their respective connector and connect Pin 4 of the MIDI IN connector to ground (pin 5 of the SoundBlaster connector) and Pin 4 of the MIDI OUT connector to +5 volts (pin 8 of the SoundBlaster connector).

Table 1. As to which modem is best for Internet use, I recommend a 14.4K bps with V.32*bis* compatibility. V.42 error-correction is optional but desirable.

Too Many Adapter Cards, Two Few Resources

Q. *I have a 486SX multimedia system with a 330M SCSI hard disk, Chinon CD-ROM, bus mouse and Adaptec sound card. I also have an external modem I use with CompuServe. Last week, I got an incredible buy on a 14.4K-bps internal modem, but I can't get it to work. I've tried everything. Am I forever stuck with a 1,200-bps external modem?*—R. Green, Pasadena, MD

A. Mr. Green describes a fairly typical problem in attempting to add peripherals to an already-loaded multimedia system. That is, the PC's resources are stretched to their limit. In a standard 286/386/486-class computer, the standard base address and interrupts for the four serial ports are:

PortBase	Address	IRQ
COM1	03F8	4
COM2	02F8	3
COM3	03E8	4
COM4	02E8	3

The sound card, by itself requires, two COM ports and three interrupts (two of which are at IRQ3 and IRQ7), leaving little available for other adapter cards and communications devices. Fortunately, most adapter cards have jumpers or switches that can be used to change the base address, and IRQ is often adjustable. Because you have a bus mouse, the conflict is with COM3. The solution to your particular problem is to set your bus mouse to IRQ5, then set the modem to COM3 and IRQ4.

Recently, a friend of mine installed AOL software on her system, and spent two days on the telephone with AOL tech support before it actually worked. Her magic number was COM3 with an IRQ4 interrupt, too, even though the modem had been running under COM2 for many years using another communications program. Hmm...maybe there's a pattern here.

If you had special problems with installing a modem or communications program, send me your solution and I'll share it with other readers. I know I've been over this subject many times in past columns, but with the proliferation of on-line usage, it's an increasing problem—and an answer I'll repeat again in the next few months (my apologies to frequent readers who find it boring). Sure will be glad when "plug-n-play" is more than a buzzword.

Windows Needs COM-Port Continuity

Q. *I have a problem with my 386DX/40 that no one can seem to solve. Maybe you know the answer. I use* Telix *for DOS and it runs fine if I boot into DOS and then run the program. However, if I run* Windows *and then shell to DOS and try to run* Telix *or any other communications program, the computer locks up. The only way I can use* Telix *after running* Windows *is to reset the computer. What can I do so that I don't have to reset after running* Windows *to run* Telix*? I have my modem set for COM4 and IRQ3. I use COM1 for the mouse; COM2 is unused, as is COM3.*—M. Nowowiejski, via Internet

A. The problem is *Windows* 3.1's unwillingness to recognize COM ports out of sequence. This means if COM1 and COM2 are in use, and you set your modem to COM4, *Windows* will either report it as COM3 or fail to see the device at all. The cure to your problem is to set your modem for COM2 and then adjust your *Windows* configuration accordingly (Fig. 3)

Sun Microsystems RGB Monitor

Q. *I obtained a Sun Microsystems 16" color video monitor with some other computer hardware at an auction, but I don't know how to connect it to my PC computer. The monitor has a "13w3" connector on the back that I'd like to plug into my Diamond SpeedStar Super VGA card. Can you tell me how to use this monitor or suggest a source for this information?*—P. Christensen, via America Online

A. While my experience with Sun systems leads me to believe it will work with your Diamond video card, I can't say for certain without looking at the monitor. For starters, the monitor must be of the multisync variety that can adjust its horizontal scan rate to one of the video modes of the Diamond card. Some early Sun monitors were the fixed-frequency type that aren't PC-compatible.

Next you need to buy a special video cable. Many Sun monitors have five BNC connectors in addition to the "13w3" connector you mention. These BNC inputs accept video signals for red, green, blue, vertical sync and horizontal sync. If this is the case, I suggest you use them for your video input because these cables are easily obtained from computer stores like Egghead. Just make sure it's the PC version and not the Macintosh version. If all you have is the "13w3" connector, it's more difficult to find a suitable cable. In this case, I'd let my fingers do the walking through the Yellow Pages to locate a dealer who may have one in stock. Expect to be asked for the model and serial number of the monitor.

The problem with buying used equipment at auctions and flea markets is that people sell it for a reason—generally because it's obsolete or incompatible with their systems.

Needs a SoundBlaster MIDI Connection

Q. *For a long time, I've been using my SoundBlaster's MIDI connector for my joystick. But now I need both a game port and MIDI port. Is it possible to use the same connector for both?*—S. Richmond, Lexington, KY

A. Many sound cards have a 15-pin connector that serves as both a MIDI and game port. Nine of the pins are used by the joystick and five are used by MIDI, with one pin (ground) in common. Yes, you can use both at the same time—if you have the proper adapter. You can purchase the adapter from Creative Labs (tel.: 408-428-6600 and ask for the MIDI Kit), or you can make your own using the schematic given in Fig. 4. Take note, though, that many sound cards have jumpers that must be set to enable both ports. So make sure your MIDI port is engaged when making the upgrade.

In Search of BNU

Q. *In a recent column about problems with 14.4K modems due to 8250 or 16450 UART chips, you mentioned a software driver that would fix the problem. I think it was BNN. I've been unable to find this driver on AOL or elsewhere. Could you please tell me what BBS has this driver.*—PDEK, via America Online

A. It's called BNU, and it's available on AOL in the Computing forum. You might try searching for it under the keyword X00. To run the program, type the following at the DOS prompt: BNU /R2048.

I didn't state that BNU was a cure-all. It's a way to protect drop-out of your serial port using data buffering and subsequent loss of the carrier. Personally, I've never used this FOSSIL driver. So I'm relying on the accuracy of my sources. Let me know what you think of it.

User Tip

If you've ever struggled through the "Abort, Retry, Fail?" prompt, you can appreciate this undocumented feature. Simply add the /F switch to the end of your CONFIG.SYS SHELL line to avoid it altogether. For example, if your SHELL line reads: SHELL=C:\COMMAND.COM /P /E:416, change it to read "SHELL=C:\COMMAND.COM /P /E:416 /F." Now instead of the "Abort, Retry, Fail?" prompt, DOS responds with the prompt, "Current drive is no longer valid." After this, you tell DOS which drive you want to be valid. *Submitted by Sue Hall of Chatsworth, CA.*

By Yacco

GUI Guts

Windows 95 Forever

It seems like I'm spending all my time these days installing one build of *Windows 95* or another. No sooner did I load build 480 than I got an e-mail telling me that Microsoft wanted everyone to move to 490 prior to an expansion of the beta program. Since the preview beta program closed before a lot of users could get a copy, an expansion seems like a great idea.

One saving grace is the continued ease of the installation. So, far I've had only one problem with *Windows 95*. True enough, it's a pretty dumb one, one that's totally unnecessary and that gave me an intolerable headache. But, hey, who's counting. It would be great if *Windows* could solve every hardware problem, but what operating system can? However I don't think it's unreasonable to ask the operating system not to create additional problems with its installation process.

I don't really mind spending more time loading *Windows 95* than running it—especially since I finally got a product manager to help me figure out why I couldn't get the NEC Versa M/75 to work with the system's built-in PCMCIA drivers. This was the one problem I ran into, and it was one that *Windows* couldn't help me solve. Of course not. It was causing the problem in the first place.

It seems the Versa has a power-conservation setting that will let you turn off the PCMCIA controller. As part of it's hardware inventory, *Windows 95* very conveniently turns off this setting. This setting is something I've never before run across in a portable computer. Considering that PC Cards are the machine's only road to expandability and even to communications, it seems like a rather unnecessary feature. However, there's no excuse for *Windows* turning it off, and leaving it in this condition. To top it off, the software doesn't help you figure out what the problem is. All it tells you is that the modem isn't operating. Now that I know why, I'd really like to give *Windows* a kick where it will do the most good.

Other than PCMCIA support, though, *Windows 95* does an excellent job with installation. Well, almost. There was one other little thing, but I'll get to that later.

The Microsoft Network

The important thing is that I've gotten past my chip-power problems. The modem is working, and I'm onto the controversial Microsoft Network (MSN). *Wheee!* There's been a lot of concern expressed that Microsoft will gain an unfair advantage by bundling MSN into *Windows*. This characterization is unfair to both Microsoft and to the other on-line providers.

It's unfair to Microsoft because its competitors have been playing marketing hardball for years. AOL bundles offers for its service with magazines and television channels that reach far more people than any computer program. CompuServe has bundled offers with virtually every major communications application sold for the past 10 or 15 years. I'd say Microsoft has its work cut out for it in overcoming those marketing programs.

There's an axiom that you can't sell a product that someone else is giving away. For example, that makes it difficult to sell a utility that's already part of the operating system—even if the add-on product is technically superior. If Microsoft were giving away MSN, this might be an appropriate analogy. But it's not. At least it won't be once the operating system goes on sale and MSN goes on-line.

During beta testing, MSN is free. Nevertheless, it's no competition for anyone at this point. It's not even up and running a lot of the time. In fact, I have yet to receive an e-mail I sent myself from MSN several days ago.

Concerns about MSN are also unfair to Microsoft's established competitors. They ignore the years they've spent building features into their services. It seems doubtful that Microsoft can float an equivalent service fully formed at birth like an electronic Venus on the half shell. CompuServe and AOL each have infrastructures and feature sets that appeal to their established users. They also have the advantage of an established interface. Users will have to learn the MSN interface if they change. Finally, each of the established services has a distinctive culture. Microsoft will have to create an entire community of it's own before it's a challenge to the established services.

The MSN bundle is an advantage in the sense that it puts the product into the hands of users, but it doesn't mean that they'll choose to use it. Microsoft does have a good track record of getting the markets it goes after, but its been able to do it with superior products and by seeing trends that competitors ignore. If Microsoft repeats that kind of performance in the area of on-line services, it will deserve to win there, too.

One thing that looks very promising is a recent announcement that Microsoft has formed several strategic alliances to build parental-access controls into software. Presumably, it will employ those controls on its own network and avoid the idiotic Keystone-Kop police state that one major competitor has implemented.

Personal Netscape

More competition, for all on-line-service providers, is looming on the World Wide Web. Internet-access providers are going into high gear to bring people to the Internet without benefit of the on-line-service providers.

There's a strong incentive to provide this direct connection. Many on-line advertisers want access to customers without having to go through an intermediary on-line-service provider. They'd rather meet you on the World Wide Web than on MSN.

To satisfy the need for Web software, several companies are offering browsers based on the original NCSA *Mosaic*. The leader is Netscape Communications, and products based on the company's

browser are popping up everywhere. It's a great browser that incorporates more features than the competition. Moreover, new registration routines are making it easy for anyone to install it on the first try. The process is totally transparent to the user.

These products can present some problems for users, though, if they have more-sophisticated needs. All of the problems stem from the effort to keep users from any sense of the Internet's complicated environment.

Netscape's own introductory-level product, *Personal Netscape*, is no exception. While the Internet is far too obscure for the average user *Personal Netscape* seeks to serve, this software leaves users totally without options, other than a choice of service provider. So, for instance, you can't use *Personal Netscape* to access a pre-existing account, not even if the account is with one of the three providers that are configured into the software.

The software also treats your computer like it's personal property. Much like in the days of early computers, software often acted as if it was the sole application on the computer, my late beta of *Personal Netscape* treated *Windows* like it was the only Internet software in the world. If you have another WinSock, it's likely to get unceremoniously bumped. Worse, you could wind up with irreversible changes to your SYSTEM.INI file.

Of course the SYSTEM.INI changes aren't really irreversible. *Personal Netscape*'s efforts to insulate you from the system just makes them seem that way. If you're unlucky enough to have a conflicting piece of software, you might have to reinstall *Windows* and all the other applications on your system.

When I complained about the beta's rude behavior, Netscape sent me a shipping copy of the program to test. The idea is for me to discover if the shipping product has the same problem as the beta. My guess is that it does. The beta reached me only a few days before the product actually shipped. However, I won't get to try it anytime soon. My system suffered so much trouble as a result of the installation that I still haven't recovered. I've discovered that at least part of my problem stems from a conflict with the PCMCIA software that supports my PC Card modem. However, it's going to be a long time before I can spare any further efforts to straighten out the mess. I'd like to get Netscape to do it for me. So far, I haven't even had time to ask the company for help.

One of the reasons I've been so busy is that I installed another of Netscape's products on the same machine. It was an OEM version of *Netscape* that's being bundled by my local provider. Earthlink's *Total Internet Access* uses the commercial version of *Netscape* to achieve the same installation ease as *Personal Netscape*.

Earthlink wrote it's own sign-up routine that automatically logs users onto Earthlink. It's every bit as easy to install as *Personal Netscape*, and Earthlink has a toll-free network in place now that allows it to market service nation-wide. I even got a free copy bundled with my last issue of *Interactive Age*.

However, when I installed *Total Access*, it also clobbered *Personal Netscape* without warning and made no copies of any of the files it changed. Like *Personal Netscape*, *Total Access* imperils any complicated system that would attempt to employ it with other access software and providers.

I'd recommend both of these products for the application where they were intended: quick and easy Internet connections. If you plan on having multiple installations on a single computer, make copies of all your system files, and be prepared to do some fancy file juggling. I'm not entirely sure how you can do it, and this means the publishers of these products should be building the capability into the next version of their software.

One final note: *Personal Netscape* has the latest Internet security features built into it. Indeed, secure Internet connections display a little key logo to let you know you're safe. Why then does *Netscape* store all of your account information, including passwords, in a reference file that anyone can read? I don't get it, but a hacker with momentary access to your hard disk can easily get permanent access to your Internet account, including your e-mail, by simply looking into the right .INI file. What good is Internet security if someone else can log on as you? I don't know. Maybe I'm missing something here.

Cruising the Web

Lamentably, even when your socket is fired up, your modem is working and you've gotten on the Internet with ease, you may be disappointed by what you find on the World Wide Web. If not exactly by what you find there, then by how you find it. Nothing takes the fun out of net surfing like waiting for image and sound files to down-load before you can see a Web page.

At least until prices drop, the state-of-the-art is likely to remain ordinary analog telephone lines. Few users can afford the digital T1 lines that corporations use to cruise the Web with full-motion video and sound. Integrated Services Digital Network (ISDN) connections, where not inaccessible, are frequently expensive. ISDN hardware can set you back some, too.

The good news is that the V.34 standard has finally been set, and manufacturers are shipping new 28.8K-bps modems based on it. They're potentially twice as fast as 14.4K-bps modems, and they're already seeing wide support. Earthlink has had V.34 modems virtually from the first day they were available. CompuServe, which recently dropped its surcharge for fast connections, is installing them as well.

I recently tested Web performance with several modems, including the Supra-FAXModem 288 external and the Megahertz XJ2288, Angia SafeJack and New Media V.34 Net Surfer PC Card modems. Response improved considerably, though not by a factor of two. In most cases, doubled speed would be an unreasonable expectation for a V.34 modem since the modem isn't the only factor involved. You need absolutely ideal circumstances to double the throughput of a 14.4K modem.

Line condition limits a modem's speed, and every Internet connection uses a different path, depending on which is best for your packets. One time, it may be direct across the country. Another time, packets may go around the world to get across the street.

In one test I conducted, the time required to go from Earthlink's home page to the Ceolas site and download its Celtic music-resource page took from 11 to 14 seconds using a 14.4K-bps modem and from 9 to 20 seconds using a V.34 modem.

The V.34 modems were more impressive in other tests. In a typical test, it took 1:50 to download 200K with a 14.4K-bps modem, compared to 1:21 with a V.34 modem. Similarly, it took 4:47 *versus* 3:22 to download a 500K file.

From Ceolas, I went to the Whistling Dixie site and downloaded selections from one of the first albums to be published online. To download the 817,085-byte version of "Barbara Allen" required 7:29 for a 14.4K-bps modem but just 5:35 for a 28.8K-bps modem.

Modem Notes

If you want to obtain the best possible performance from a 28.8K-bps modem, there's one thing you need to avoid. These modems support V.42 and MNP 4 error correction, as well as V.42bis and MNP5 compression protocols. You might be tempted to use these features on the Web. However, using compression to download Web files is unlikely to result in smaller file sizes, and it still costs you the time it takes to run the compression algorithm.

Earthlink support warned me that all Web packets are compressed, as part of the protocol, and advised me to set my port to 38,400 bps, rather than its 115,200 bps maximum. A 28.8K-bps modem can theoretically achieve 115,200 bps with compression, but it's not likely on the Web.

Compression restrictions apply to 14.4K-bps modems as well as to 28.8K-bps modems. However, there's one additional hurdle to overcome for a V.34 modem: a lack of driver support. The com- munication driver for *Windows* 3.1 doesn't support port speeds beyond 19,200 bps. (*Windows for Workgroups* 3.11 does support higher speeds.) Fortunately, Megahertz and Supra supply high-speed replacement drivers for *Windows* 3.1.

Among the other salient features on the SupraFAXModem 288 are Caller ID and the ability to automatically differentiate between incoming voice and fax calls.

Both Megahertz and Anglia have voltage protection built into their modems. This allows them to be used in hotel rooms and with other strange circuits without fear that a digital line will inadvertently destroy them.

Incidentally, you can get over-voltage protection for any modem with a Konexx. This device simply adapts your modem to the modular handset port on any telephone, and that port is always analog. So, in addition to protecting you from digital telephones, Konexx lets you work with them. I never travel without Konexx, and I'm happy to report that Unlimited Systems has shipped a new 28.8K-bps Model 111 that supports these faster speeds.

Megahertz and Anglia each have receptacles for RJ-11 modular plugs built into them. If you're concerned that you might accidentally break or lose this type of connector, you can choose the New Media Net Surfer. Of all the special cables I've seen, this is the best possible design. All the electronics are inside the card, and the cable is an ordinary modular wire with an RJ-11 connector on one end. Though the other end has a proprietary AMP connector, unlike some, it latches into the card to prevent accidental removal.

Norton Utilities 95

The *Norton Utilities* for the *Windows 95* Preview is loaded with diagnostics and utilities that can help you tune up the operating system and recover from problems. *Norton* for 95 has the same sort of file-recovery tools, disk optimization, rescue disks and such that it has for DOS. Unfortunately, *Norton* couldn't help with my installation woes because it doesn't yet include support for PC Cards. I'm hopeful that it will offer analysis of PCMCIA devices and drivers when the product ships with the release of *Windows 95*.

Windows 95 needs help in this area beyond its dopey installation goof. My troubles with *Windows 95* installation also led me to discover that the system's support for PC Cards somewhat resembles the disorganized printer support in *Windows* 3.x. It's spread over several places in the control panel, including a System tool that hides some functions fairly effectively.

Norton did alert me to my other installation problem. *Windows* doesn't recognize the 24-bit color driver for the Versa's true-color active-matrix display. At least *Norton* didn't find any specifications in the registry where *Windows* is supposed to record such data. *Norton* accurately reported all other system information (save the aforementioned PC Card sockets).

My preview version of *Norton* didn't come with much in the way of documentation. What I could discover about the Space Wizard without it didn't impress me much. It seemed that most of the files that were presented for possible elimination were most likely created by *Norton* in the first place. Furthermore, *Norton* didn't give me enough information about redundant files to help me make a decision on what to delete. Any file manager would do a better job.

I also found creation of a rescue disk a risky and confusing process. *Norton* offered to overwrite files without a dialog box that shows the origin and destination of the files in question. It was impossible to know whether or not I'd be replacing files with newer versions or older ones. In fact, when I accepted the replacement it offered for build 480, the files it installed turned out to be older. (*Windows* has the integrity to restore the original files, but the system seemed to run equally well with either set.)

Coincidentally, a few days after I installed the preview *Utilities*, and discovered its deficiencies, I happened to run into Peter Norton in Santa Monica. We were both having lunch at the Light House, and as we stood next to each other at the sushi buffet, I couldn't help mentioning how much more confidence I'd had in the software when he'd actually had regular personal involvement in its development. I doubt that the news affected his lunch, but I know I'd feel better about the *Utilities* reorganizing my hard disk if they didn't have minor oversights.

Enough About *Windows 95*

Linux isn't an alternative to *Windows 95*. It's a 32-bit Internet-ready, multi-user, multitasking GUI alternative to *Windows NT* with support for full multimedia. Workgroup Solutions president Mark Bolzern says, "My personal opinion is that Unix is what Bill Gates is trying to create."

WGS Linux includes a World Wide Web server, DOS emulation, *Windows for Workgroups* LAN Server, SCO Unix emulation, e-mail, C, C++, Perl, Fortran, Pas-

cal, Lisp, Smalltalk, TCL, TK, FlagShip "Test-Drive", *X-Windows*, full networking (TCP/IP, NFS, NETBIOS, Usenet News, HTTP, HTML, etc.) and clones of virtually every Unix utility. Linux even has Posix compliance, with security.

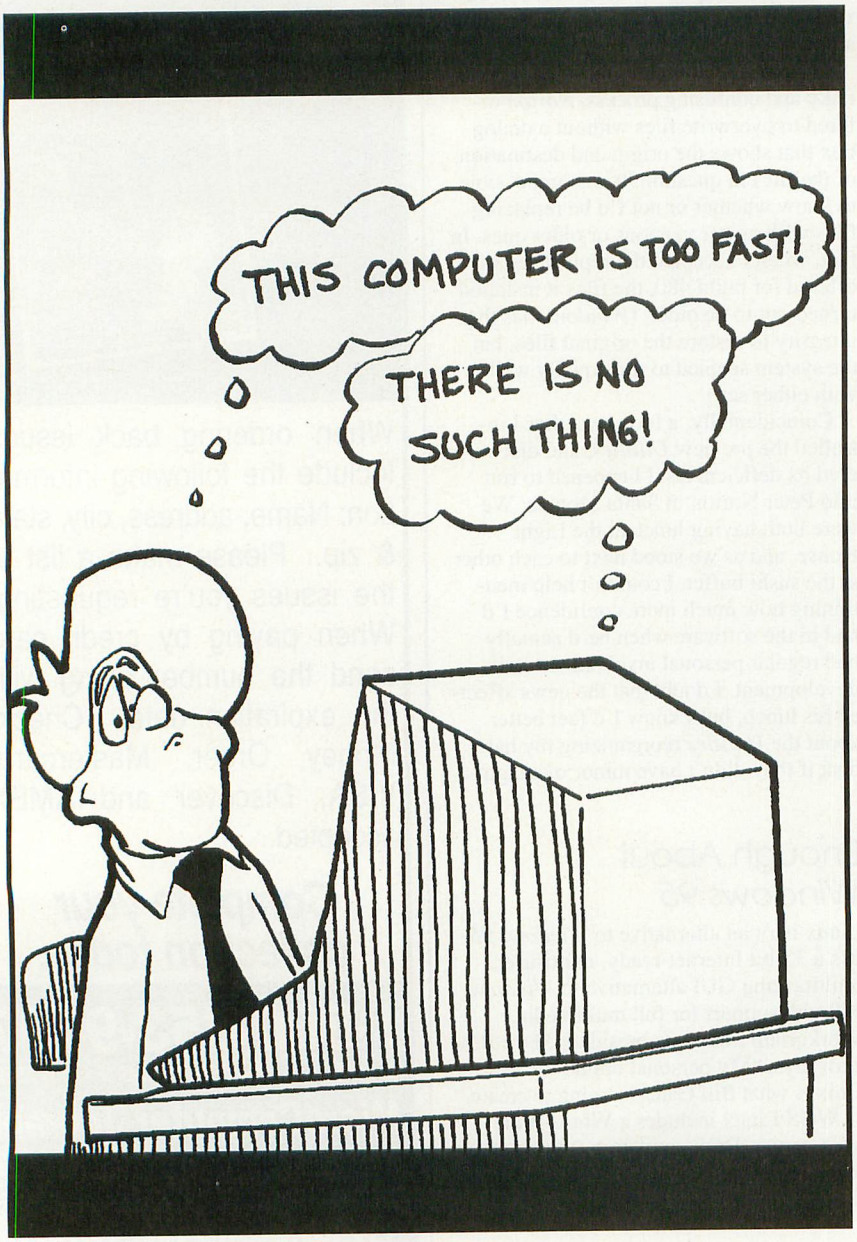
In addition to claiming that Linux delivers the functionality that Microsoft wants *NT* to provide, Bolzern believes that 50% of Internet providers are using Linux on PCs. However, there's big difference in price between the Linux and *NT*. At $19, the entry-level WGS *Linux Pro* CD contains "not necessarily the latest," but the files that WGS has selected as the best of Linux. The $29 WGS *Linux Pro* four-CD set includes the WGS *Linux Pro* CD and three other discs that do contain the very latest code from the primary archive sites for Linux, as well as from the Sunsite and TSX-11 FTP sites. The $69 WGS *Linux Pro Compendium* adds a 1,200-page manual and technical support to the four-CD set.

Linux was independently developed piecemeal by users across the Internet. The Free Software Foundation brought together the parts in an archive and created the GNU license under which Linux is distributed. The Linux GNU license can be sold or freely distributed. The only restrictions are that the copyright is retained by GNU and that source code must be provided if requested and for no more than the cost of handling.

WGS took the basic GNU Linux and enhanced it, producing what the company calls a "commercially stable, professionally packaged" version of Linux. While the 1,200 pages of documentation that accompany the WGS *Pro Compendium* constitute no more than a tiny fraction of the volume of a major commercial Unix product, the book is quite a synopsis of Unix. From the view of WGS, it gives away the software and charges for the support, manual and packaging. However you look at it, the package costs less than $70.

You can also sell Linux. This means that you can buy one copy of WGS from WGS and install it on all of your client's machines and charge only for your time.

Minimum hardware requirements for Linux are a 386-caliber or better processor with at least 4M of RAM and an 80M hard disk. WGS recommends a 486-caliber processor with 16M of RAM and a 500M drive. ■



Products Mentioned

Linux Pro, $69
WorkGroup Solutions
info@wgs.com

SupraFAXModem 288, $264.95
Supra Corp.
312 S.E. Stone Mill Dr., Ste. 150
Vancouver, WA 98684
Tel.: 206-905-1400

CIRCLE NO. 150 ON FREE INFORMATION CARD

XJ2288, $399
Megahertz Corp.
605 N. 5600 W.
Salt Lake City, UT 84116
Tel.: 800-527-8677 or 801-320-7000

CIRCLE NO. 151 ON FREE INFORMATION CARD

SafeJack 28.8, $389
Angia Communications
441 E. Bay Blvd.
Provo, UT 84605-0540
Tel.: 800-877-9159 or 801-371-0488

CIRCLE NO. 152 ON FREE INFORMATION CARD

V.34 Net Surfer, $350
New Media Corp.
15375 Barranca, Bldg. B-101
Irvine, CA 92718
Tel.: 714-453-0100

CIRCLE NO. 153 ON FREE INFORMATION CARD

Model 111, $159
Unlimited Systems Corp., Inc.
8586 Miramar Pl.
San Diego, CA 92121
Tel.: 800-275-6354 or 619-622-1400

CIRCLE NO. 154 ON FREE INFORMATION CARD

Industry Watch By John Hastings

The AmCoEx Index of Used Computer Prices

Microsoft appears to be caught between a rock and a hard place. Following several postponements, it has announced it will release its next operating system, *Windows 95*, in August. However, the most-recent beta, or test, version of the software reveals that many problems have yet to be solved. If these problems can't be completely eradicated before August, the shipping date will slip once again. This could cost Microsoft millions of dollars of anticipated revenue for this year. Even a minor delay in shipping will preclude computer manufacturers from pre-installing the new operating system on the computers they'll sell through the fourth quarter of this year, which is the largest sales quarter of any year. In addition, IBM and Apple are making major improvements in their software to stay ahead of Microsoft's efforts. IBM's OS/2 continues to get rave reviews and is selling in record numbers. If Microsoft doesn't respond soon, it could face a shrinking market.

On the other hand, if Microsoft rushes a buggy product to market to meet fourth-quarter goals, the support problems that could create could cost the software giant as much in additional support costs, customer frustration and tainted reputation as the other alternative. This will easily be the largest software upgrade in the history of computers. Even the slightest flaw will be amplified by millions of users. When *Windows* 3.0 was released, the software was so unstable it was almost unusable. But with a relatively small number of users, the problems were manageable. The large adoption of *Windows* didn't occur until after the more-stable Version 3.1 was released.

Apple has completed a reorganization that will expedite its moves to create clones of the Macintosh computer. While the company has given lip service to this direction, little real progress has been made. Only a handful of small companies are currently planning to build clones of the Macintosh.

Many say the reason Apple hasn't aligned with any large computer makers was due to internal resistance by some hardware departments that felt they'd suffer with more competition from clone hardware. The software groups, which stood the most to gain from cloning, couldn't overrule the opposition. Now these groups are under the same management. Many experts have said this is exactly what Apple needed to do to make real progress in expanding market share for the Macintosh. Some people expect to see new agreements with large manufacturers signed soon. This will certainly bring lower prices to new and used Macintosh computers.

In the near future—some people say five and others say ten years—the term "literate" will describe a person who can read, write and use a computer. The lack of any computer skills will be equiv- alent to people today who can't read. At that point, computers will permeate every aspect of our lives. As is almost the case today, a person will need to be knowledgeable in computers to get almost any entry-level job. Within a few years, however, the permeation will go much deeper.

The conventions of the graphical interface used on Macintosh and *Windows* computers today will be utilized for the controls on everything we use. Our automobiles, television receivers, VCRs, microwave ovens and a host of other appliances will be controlled through the conventions of the graphical interface. Almost everything that seems complicated today will be simplified with this type of interface. The premise will be that everyone understands this interface. Due to the fact that one out of every three homes today has a computer, this is a logical conclusion.

The year 2000 could be the bewitching year for many computer programs. Some experts fear that there are thousands of computer programs that will begin to make many erroneous calculations on January 1, 2000. Many programs today calculate years by subtracting the last two digits from the beginning and ending dates. For example, 99 minus 95 would yield a four-year difference. However, subtracting 95 from 02 would yield an answer of –93, not seven, as needed. The fix for this type of problem is fairly simple, assuming the company that developed the program is still in business and still enhancing the product.

Prices of record-able CD-ROM drives and disks are dropping at an astonishing rate. Currently, new drives are selling for less than $1,700 and disks have fallen from $20 to less than $10 apiece. Since each disk can store more than 600M of data, this system provides for very-affordable storage of large quantities of data. Close on its heels, however, is a new system many people think will replace the floppy drive as the new storage medium of choice.

Iomega Corp. has introduced the Zip drive that sells for less than $200 and uses disks that hold 100M of data and sell for less than $20 each. These prices are currently low enough to foster widespread adoption. This could create economies of scale that would permit dramatic price cuts in the near future. The greatest advantage the 3½" disks have over CD-ROMs is that they can be erased and reused over and over again. On CD-ROMs, data can be written only once. Zip disks are faster when reading data than CD-ROMs, too. While not as fast as some new hard drives, they're comparable to some older hard drives when accessing data.

Prices for used Macintosh PowerBooks continue to fall as Apple continues to cut prices on most new models. In the first week in May, Apple cut the price of the PowerBook 150 by 27%. Some dealers are currently selling the low-end PowerBook for less than $1,000. Many people think Apple is clearing inventory before introducing PowerPC versions of its PowerBooks this summer.

A new product has caused great alarm to the long distance telephone companies. A $49 package known as the Internet Phone, developed by VocalTec Inc., allows users on the Internet to talk to each other without long-distance charges. For the cost of the connection to the Internet, a user can talk to another Internet Phone user anywhere in the world. Some people expect this technology to soon incorporate video transmission as well.

More News

This year may be the first in which computers built around Pentium CPUs outsell computers with 486 CPUs. Each preceding generation change has been due to demand, but this one may be strictly based on supply. It seems Intel is determined to move the market forward and intends to restrict production of lower-priced 486 chips. It will convert production capacity to more Pentium production. While other makers, like Advanced Micro Devices, attempt to increase production of their 486 lines, they can't meet the shortfall left by Intel.

NexGen is now shipping the first clone of the Pentium chip. Called the Nx586, early adopters have said the chip runs about twice as fast as a 486/66 chip. Several small manufacturers are currently selling computers with this chip, and Compaq has announced that it will soon offer the chip in some models of its computers. With prices that are approximately $300 less than comparable Pentium-based computers, this 586 could be a big hit.

As the price of color notebook computers drops, their market share increases. In 1993, less than half of all notebook computers sold had color screens. In 1994, more than 75% were color. The more-expensive active-matrix color is gaining ground as well. A year ago, active-matrix color commanded a $1,000 premium over passive-matrix color. Today, the difference is less than $500.

The Internet, or one of its successors, will change our lives, and some people say the changes will begin sooner than expected. The Internet currently offers enormous amounts of information. The challenge is to locate needed information. It's like a large library that has no card-catalog system. Intelligent agents will soon solve this. These software agents will scan the reams of data available on the Internet and bring back only the sought-after items.

Transferring large quantities of data—be it articles, photos, film clips or books—to our own computers is the next bottleneck. Connections to the Internet today are too slow for large data transfers. The solution may be in the cable that brings you cable TV. LANcity Corp. will begin selling a modem this summer that will permit computers to connect to the Internet through a cable-TV connection. Data transfer rates with this connection will be approximately 1,000 times faster than current telephone connections. With two out of every three homes in the United States currently wired for cable TV, this opens the door to enormous opportunities. The entire educational system will be enhanced, if not eventually replaced, by the power of this network.

While the original designers of the Internet didn't plan for this type of usage, successors to the Internet will certainly incorporate the necessary features. Both AT&T and MCI have Internet-like systems on their drawing boards. All of the pieces to this puzzle currently exist. It's simply a question of how fast they can be brought together.

The home-computer marketplace is exploding. In 1994, Americans spent more money on home-computer equipment than on television receivers. Computer software and hardware companies are sensing this trend and adjusting their products and marketing accordingly. Some companies, like Apple Computer, have always had a strong presence in the home-computer marketplace. These companies will benefit the most from this trend. Most other computer manufacturers have always coveted the corporate market. For them, the transition to catering to the home market will be more difficult. Although Apple, Intel and Microsoft have used TV advertising for years, dozens of companies are expected to join their ranks in the near future.

This influx of advertisers will create a need for more computer-oriented TV pro-

The following prices are for May 1, 1995

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change($)
IBM PS/2 Model 70, 60M	$350	$600	$425	+50
IBM PS/1 486DX2/50, 253M	800	1,350	925	–50
IBM PS/2 Model 90, 160M	1,000	1,500	1,050	—
IBM ThinkPad 350C	1,700	2,100	1,825	–75
IBM ThinkPad 700	900	1,500	1,075	–75
IBM ThinkPad 720	1,300	2,000	1,375	–50
AST 486SX/25, 170M	700	1,250	775	–75
AST 486DX/66, 340M	950	1,450	1,000	–50
Dell 386/33, 100M	450	850	550	–50
Dell 486DX/33, 240M	850	1,500	900	–75
Gateway 386/25, 80M	400	800	475	–25
Gateway 486/33, 120M	800	1,200	925	–25
Clone Notebook 386SX, 40M	400	900	500	–50
Clone 386/33, 80M, VGA	450	800	450	–50
Clone 486/25, 120M, VGA	700	1,200	950	–25
Clone 486DX/33, 240M	800	1,425	1,000	–75
Compaq LTE 286, 40M	250	675	300	—
Compaq Contura 320, 60M	500	1,000	675	–100
Compaq Contura 4/25, 120M	900	1,400	1,000	–125
Compaq Deskpro 386/20e, 100M	400	800	475	–50
Compaq Deskpro 486/33, 120M	800	1,450	950	–25
Mac Classic II, 80M	400	800	425	—
Mac IIsi, 160M	500	900	575	–25
Macintosh IIcx, 80M	300	700	325	+25
Macintosh IIci 80M	500	950	600	–25
Macintosh IIfx, 80M	600	1,000	725	–50
Mac Quadra 700, 230M	1,100	1,600	1,200	—
Mac Quadra 800, 500M	1,600	2,300	1,800	–125
PowerBook 140, 40M	700	1,100	750	–75
PowerBook 170, 40M	800	1,350	875	–100
PowerBook 180, 80M	1,200	1,850	1,525	–100
LaserWriterPro 630	1,300	1,775	1,375	–100
Toshiba 1900, 120M	675	1,150	725	–100
Toshiba 3200 SXC, 120M	1,850	2,950	2,150	–75
Toshiba 3300SL, 120M	850	1,300	925	—
Toshiba 5200, 100M	750	1,050	800	–50
HP LaserJet II	350	850	425	–25
HP LaserJet IIIP	350	950	375	—
HP LaserJet III	600	950	625	+25
HP LaserJet IV	900	1,300	950	—

gramming. During the next year, dozens of new TV computer shows are expected to debut on the major networks.

New technology is being developed to accommodate the home market. Apple Computer has developed a new high-speed serial bus called FireWire. This technology will permit computer users to connect VCRs, camcorders, digital cameras and a host of other devices directly to the serial ports of their computers, eliminating the need for expensive cards currently needed. Apple is licensing this technology to other computer companies, in hopes of making it a new standard. Many companies are also incorporating TV, telephones, answering machines and voice mail into new computer models.

Telephone companies are adding new lines at an astonishing rate. Witness the changes in many area codes. Most of these new lines are ordered to handle modems and fax machines. Virtually every business and many homes have added one or more lines for these devices. The telephone companies must be pleased with the advent of this technology. However, newer technology may reverse this trend.

Most modem makers are preparing to introduce new products that incorporate SVD, simultaneous voice and data transmissions. This will permit a person to talk and receive a fax or data on the same telephone line at the same time. This capability, coupled with inexpensive cameras, will accelerate adoption of videoconferencing.

In addition, many modem makers are incorporating a feature that works with distinctive ringing. This is a service many telephone companies offer that assigns three different numbers to one telephone line. Each number has a different ring pattern. The new modems will differentiate the pattern and route the call to a fax, data or voice connection.

Many computer retailers offer a money-back guarantee on the computers they sell. These policies permit some users to return computers that have no problems. The Federal Trade Commission is investigating several computer makers to learn how they handle this returned merchandise. It's suspected that some vendors resell these computers as new units. Larger makers like Apple and Compaq normally sell these as refurbished units through used-computer equipment dealers. ■

Prices For Used-Computer Equipment as of June 2, 1995

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change($)
IBM PS/2 Model 70, 60M	$350	$600	$375	-50
IBM PS/1 486DX2/50, 253M	800	1,350	900	-25
IBM PS/2 Model 90, 160M	900	1,300	1,000	-50
IBM ThinkPad 350C	1,600	1,950	1,750	-75
IBM ThinkPad 700	900	1,500	1,000	-75
IBM ThinkPad 720	1,100	1,800	1,350	-25
AST 486SX/25, 170M	650	1,050	700	-75
AST 486DX/66, 340M	850	1,400	925	-75
Dell 386/33, 100M	450	850	475	-75
Dell 486DX/33, 240M	700	1,150	825	-75
Gateway 386/25, 80M	350	700	400	-75
Gateway 486/33, 120M	700	1,100	900	-25
Clone Notebook 386SX, 40M	400	900	450	-50
Clone 386/33, 80M, VGA	350	700	400	-25
Clone 486/25, 120M, VGA	700	1,200	850	-100
Clone 486DX/33, 240M	800	1,425	900	-100
Compaq LTE 286, 40M	250	67	325	+25
Compaq Contura 320, 60M	500	1,000	650	-25
Compaq Contura 4/25, 120M	900	1,400	925	-75
Compaq Deskpro 386/20e, 100M	400	800	425	-50
Compaq Deskpro 486/33, 120M	750	1,300	850	-100
Mac Classic II, 80M	350	800	425	—
Mac IIsi, 160M	500	900	550	-25
Macintosh IIcx, 80M	250	600	300	-25
Macintosh IIci, 80M	500	950	625	+25
Macintosh IIfx, 80M	600	1,000	725	—
Mac Quadra 700, 230M	1,000	1,600	1,125	-75
Mac Quadra 800, 500M	1,600	2,300	1,725	-75
PowerBook 140, 40M	700	1,100	825	+75
PowerBook 170, 40M	800	1,350	925	+50
PowerBook 180, 80M	1,200	1,850	1,500	-25
LaserWriterPro 630	1,100	1,650	1,300	-75
Toshiba 1900, 120M	675	1,150	725	—
Toshiba 3200 SXC, 120M	1,850	2,950	2,000	-150
Toshiba 3300SL, 120M	850	1,300	925	—
Toshiba 5200, 100M	750	1,050	800	—
HP LaserJet II	350	850	450	+25
HP LaserJet IIIP	250	650	350	-25
HP LaserJet III	500	900	625	—
HP LaserJet IV	800	1,200	925	-25

Since 1988, the American Computer Exchange has matched buyers and sellers of used microcomputer equipment. For more information contact the American Computer Exchange at 800-786-0717.

More On Computer Jargon

"Buying Smart" in the May/June 1995 issue was very interesting. I especially liked the DX-versus-SX explanation, but I didn't see anything on the SLC and DLC systems sometimes seen in ads. What's the difference?—*M. Nowowiejski, via Internet*

Sorry for the omission, but I assumed you would have read that information in "CPU Upgrades: The Complete Story" in the March/April 1995 issue, which describes these chips in detail. Basically, these chips are a product of Cyrix and are similar in operation to the Intel DX and DX2 CPUs, minus a built-in math coprocessor. They cost less and run slightly faster than their Intel counterparts—and they require special motherboards and BIOS chips. As a result of the differences, these CPUs aren't plug-in replacements for Intel CPUs. However, the SLC designation is also used by IBM and Intel to define their low-power versions of 386 and 486 CPUs for use in battery-powered equipment like portable PCs. If this isn't confusing enough, I recently ran across an ad touting the IBM 486BLC/75, which is IBM's Blue Lightning CPU that's similar in operation to Intel's 486DX4 (also described in the March/April 1995 issue), which I hadn't seen when perusing the periodicals for new acronyms for the jargon article.

Speaking of keeping up with the new jargon and technologies, here are a few new terms you probably haven't heard.

EDO. *Extended Data Output (Hyper-Page Mode) DRAM is a new type of RAM that runs about 30% faster than conventional DRAM. Without going into a lot of detail, it basically eliminates many of the wait-states regular DRAM needs to keep itself refreshed. EDO boosts the DTR (data transfer rate) to greater than 100M/s. This throughput rate will be needed for a new class of Native Signal Processing (NSP) applications that should appear in early 1996, which will include multi-channel sound mixing and video conferencing, among other multimedia applications. Currently this technology is available on only Pentium motherboards that sport the Intel Triton chipset.*

UltraSCSI. *This evolving SCSI interface technology has a DTR of 40M/s—twice that of SCSI-2 and eight times that of regular SCSI. UltraSCSI is backward-compatible with previous generations of SCSI standards, which makes upgrading almost painless. I stress* almost *painless because SCSI interfaces are much more software-sensitive than IDE, and the connectors aren't always interchangeable.*

Fiber Channel is another evolving SCSI interface. This time, though, fiber optics are needed to achieve the 100M/s speed of this emerging standard. Slated for release in early 1996, Fiber Channel SCSI uses SCSI serial protocol communications in a loop configuration. You'll find more details on both UntraSCSI and Fiber Channel in my feature article titled "Enhanced IDE" in this issue.—TJ Byers

Is It 16 or 32 Bits?

I'm writing in response to a Microcomputer Q&A answer that appeared in the May/June issue titled "Is It 16 or 32 bits?" I believe that many parts of your answer were somewhat incorrect and misleading.

While it's true that the 8088 has an eight-bit data bus, this doesn't make it an eight-bit microprocessor. The 8088 that drove the original IBM PC internally uses both eight- and 16-bit addresses. Because a 16-bit address is large enough to address up to only 64K of memory, the 8088 uses a staggered memory-addressing scheme (with offsets) to address up to 1M of memory.

"With the advent of Intel 32-bit microprocessors, like the 80386, came a new kind of memory addressing—sometimes called "flat" addressing. Instead of breaking a memory address into a 16-bit segment and a 16-bit offset, addresses could be specified with one 32-bit word. This not only made for faster programs, it also allowed for addressing up to 4G of memory. The problem is that 32-bit addressing is fundamentally incompatible with the older segment:offset or 16-bit addressing. Therefore, Intel had a choice: either produce 32-bit processors that are incompatible with existing 16-bit programs or build 32-bit processors with the ability to run older 16-bit programs. Intel chose to build its 32-bit processors with two modes of operation. Real mode (virtual 8086) which runs 16-bit code, and protected mode that runs 32-bit code. (*The same decision Intel had to make when hopping from the 8088 to 80286 platform, which also uses protected mode.—TJ*) DOS is written mostly in 16-bit code, which limits memory access to 640K. Therefore, the main difference between running a 16-bit operating system and a 32-bit operating system isn't exactly related to utilizing the wider bus. Instead, the advantage is using 32-bit addressing to access memory above 1 megabyte.

I also think your assessment of the various operating-system contenders isn't quite accurate. In many ways, *Windows 95* is a continuation of the *Windows* on DOS architecture of *Windows for Workgroups.—D. Max, New York University, via Internet*

There are operating systems and there are operating-system overlays. DOS is an operating system. Windows *3.1 is a DOS overlay, as is* Windows for Workgroups. Windows NT *and* Windows 95 *are operating systems, which means neither one runs off DOS. That is, DOS doesn't have to be installed to run* Windows NT *or* Windows 95. *If you're installing* Windows *3.1 or* Windows *3.11* (Windows for Workgroups), *you need DOS installed before you can load it.*

The 32-bit software issue has nothing to do with bus width, but it has everything to do with the operating system. Basically, DOS is a 16-bit operating system. Windows *3.1 is also 16 bits, but it can be extended to 32 bits using a software driver found on Microsoft's BBS and many on-line services like America Online.* Windows NT *and* Windows 95 *are 32-bit operating systems.*

Most programs today use 16-bit data code and 32-bit addressing, which makes them compatible with all versions of Windows. *For an application to run a full 32 bits of data and addresses like* Windows 95 *supports, the software has to be rewritten, which makes it incompatible with the large installed base of* Windows *3.1 users. Ditto for OS/2, which is also a 32-bit operating system.*

So why would you want to use a 32-bit operating system when most software is geared for 16 bits? Because there are fewer and fewer "old" PCs in use, and it won't be long before 486 and Pentium desktops will outnumber 286 and 386 systems. This means more programs will be crafted for the 32-bit platform. It's going to take you some time to get up to speed with the new 32-bit operating systems that aren't like anything you've used before. In most ways, Windows 95 *is a lot different from* Windows for Workgroups.—TJ Byers

Needs More On Enhanced Parallel Port

I very much enjoyed your article on the enhanced parallel port. I need to make a product that runs on the port, but the article seems to run out of steam when it comes to the software side of things. Where can I get more information? Specifically, I need to know what BIOS calls EPP supports, and whether or not there are any commercial VXDs available. My current PC software drivers use ASM directly on the parallel port. This is okay for *Windows* 3.1 and DOS but not for *Windows NT* or *Windows 95.—Craig Haller, Macraigor Systems, via Internet*

Sorry you found the software discussion sketchy, but it's because most of it isn't fully defined as yet. The specification is being hammered out as I write this, and, according to my sources, it will be a while before it sees the light of day. Fortunately, a lot of work has been done. To get the latest on this evolving specification, download the document called D3_170_D.ZIP *located at* ftp.lexmark.com:/pub/ieee/1284.3 *on the Internet. A good source of XDdrivers is MTE Software (tel.: 619-292-2050); ask for Mark Edmead. If you need additional information, contact Larry Stein at FarPoint Communications (tel.: 805-726-4420). Larry is the chairman of the IEEE P1284.3 Committee and president of FarPoint Communications, a leading supplier of EPP adapters.*—TJ Byers

Minding Your DMAs and IRQs

Proper operation of a PC depends on everything working together in harmony. The catch-all word "everything" refers to IRQs, DMA channels, I/O port addresses and base memory addresses. If any of these is in conflict with another, your PC may give you intermittent problems, such as randomly hanging up and failing to work altogether. Problems often crop up after a major upgrade, such as adding a multimedia system to your PC. If you want your upgrade to work, you must make sure to assign unique IRQs, DMAs and addresses to your new components.

Keep in mind that a new component added to a system doesn't always need to be assigned all four items. But if you do assign any of these, store the information on your computer and print out a copy for yourself for future reference. As an example, adding a modem might require the following assignments: IRQ3; I/O Port Address 02F8. Adding a sound card may require assignments such as: IRQ5; DMA1; I/O Port Address: 0220. Adding a network card may require assignments like: IRQ9; I/O Port Address 0240; Base Address D000.

Hardware and software diagnostic utilities like those mentioned in the main article supply information about the current assignments of IRQs, DMA channels, I/O port addresses and base memory addresses. Tools like these can help you avoid the problems that crop up when there are conflicts in your system.

agnostic disk is also included in the package.

Tall Tree Software's $150 *UART Expert* checks the UART chip of a serial port. This program lets you modify all parameter settings on the UART chip.

• ***Video Adapter & Monitor Diagnostics.*** General diagnostic software usually includes video tests, but it doesn't specifically address the condition of the video monitor. Sonera Technologies' $149 *DisplayMate* concentrates on this aspect of the computer system. *DisplayMate* shows how to set up, evaluate, test and adjust video displays and adapters. It includes more than 200 tests for the video monitor and more than 100 tests for the video-adapter card. Two other Sonera products, *Display Mate for Windows* and *DisplayMate Professional*, sell for $79 and $249, respectively.

Companies Mentioned

Accurite Technologies, Inc.
231 Charcot Ave.
San Jose, CA 95131
Tel.: 1-408-433-1980
CIRCLE NO. 195 ON FREE INFORMATION CARD

AllMicro, Inc.
18820 U.S. Hwy. 19N, Ste.. 215
Clearwater, FL 34624
Tel.: 1-800-653-4933 Ext. 228 (Ask for Michael Finegold)
CIRCLE NO. 196 ON FREE INFORMATION CARD

Computer & Monitor Maitenance, Inc.
6649-N1 Peachtree Ind. Blvd.
Norcross, GA 30092
Tel.: 1-800-466-4411
CIRCLE NO. 197 ON FREE INFORMATION CARD

Cybermedia
1800 Century Park E., Ste. 1145
Century City, CA 90067
Tel.: 1-310-843-0800
CIRCLE NO. 198 ON FREE INFORMATION CARD

Data Depot, Inc.
1710 Drew St.
Clearwater, FL 34615
Tel.: 1-800-275-1913
CIRCLE NO. 199 ON FREE INFORMATION CARD

DiagSoft, Inc.
5615 Scotts Valley Drive #140
Scotts Valley, CA 95066
Tel.: 1-408-438-8247
CIRCLE NO. 200 ON FREE INFORMATION CARD

E Ware
5241 Lincoln Ave., Ste. B5
Cypress, CA 90630
Tel.: 1-800-892-9950
CIRCLE NO. 201 ON FREE INFORMATION CARD

Gibson Research Corp.
35 Journey Ave.
Aliso Viejo, CA 92656
Tel.: 1-714-362-8800
CIRCLE NO. 202 ON FREE INFORMATION CARD

Helix Software Co.
47-09 30tSt.
Long Island City, NY 11101
Tel.: 1-718-392-3100
CIRCLE NO. 203 ON FREE INFORMATION CARD

ICS Electronics Corp.
473 Los Coches St.
Milpitas, CA 95035-5422
Tel.: 1-408-263-5500
CIRCLE NO. 204 ON FREE INFORMATION CARD

Landmark Research Int'l.
703 Grand Centrel St.
Clearwater, FL 34616
Tel.: 1-800-683-6696
CIRCLE NO. 205 ON FREE INFORMATION CARD

Micro 2000, Inc.
1100 East Bway., Ste. 301
Glendale, CA 91205
Tel.: 1-818-547-0125
CIRCLE NO. 206 ON FREE INFORMATION CARD

Micro House International, Inc.
4900 Pearl East Circle #101
Boulder, CO 80301
Tel.: 1-303-443-3388
CIRCLE NO. 207 ON FREE INFORMATION CARD

Micro Systems Development Tech., Inc.
4100 Moorpark Ave.
San Jose, CA 95117
Tel.: 1-408-296-4000
CIRCLE NO. 208 ON FREE INFORMATION CARD

Sencore
3200 Sencore Dr.
Sioux Falls, SD 57107
Tel.: 1-800-736-2673
CIRCLE NO. 209 ON FREE INFORMATION CARD

Sonera Technologies
4 Robin Rd.
Rumson, NJ 07760
Tel.: 1-800-932-6323
CIRCLE NO. 210 ON FREE INFORMATION CARD

Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014-2132
Tel.: 1-408-253-9600
CIRCLE NO. 211 ON FREE INFORMATION CARD

TouchStone Software Corp.
2130 Main St., Ste. 250
Huntington Beach, CA 92648
Tel.: 1-800-531-0450
CIRCLE NO. 212 ON FREE INFORMATION CARD

Trackmate
5750 Rufe Snow Dr., Ste. 130
N. Richland Hills, TX 76180
Tel.: 1-800-486-5707
CIRCLE NO. 213 ON FREE INFORMATION CARD

Ultra-X, Inc.
2005 De La Cruz Blvd., Ste. 115
Santa Clara, CA 95050
Tel.: 1-408-988-4721
CIRCLE NO. 214 ON FREE INFORMATION CARD

Windsor Technologies, Inc.
130 Alto St.
San Rafael, CA 94901
Tel.: 1-415-456-2200
CIRCLE NO. 215 ON FREE INFORMATION CARD

PC Hardware & Software Diagnostic Tools Buyer's Guide

CompanyName	Product	Price	Description
AllMicro, Inc.	Discovery Card	$299.00	Detects IRQ & DMA channels (eight-bit ISA)
AllMicro, Inc.	The AlertCard	399.00	Monitors power supply & temperature (eight-bit ISA)
Computer & Monitor Maintenance, Inc.	Checker 12	295.00	Tests monitors in all modes up to 1,024 X 768
Computer & Monitor Maintenance, Inc.	Checker JR	99.95	Tests monitors in 640 X 480 mode
Data Depot, Inc.	PocketPOST V2	299.00	Displays POST codes, bus signals, voltages; includes probe (eight-bit ISA)
Data Depot, Inc.	PocketPOST MCA	129.00	Micro Channel adapter for PocketPOST, MiniPOST, other POST cards
Data Depot, Inc.	MiniPOST	119.00	Displays POST codes (eight-bit ISA)
Data Depot, Inc.	PC PowerCheck	269.00	Checks power suppy voltages for noise, spikes, HI/LO eight-bit ISA)
ICS Electronics Corp.	EISA-EXT	595.00	Test expansion card (16-bit EISA)
ICS Electronics Corp.	VL-EXT	595.00	Test expansion card (16-bit ISA w/ VESA local bus)
ICS Electronics Corp.	AT-EXT	495.00	Test expansion card (16-bit ISA)
ICS Electronics Corp.	PC-EXT	295.00	Test expansion card (eight-bit ISA)
Micro 2000, Inc.	POST-Probe	399.00	Displays POST codes, bus signals, voltages; includes probe (eight-bit ISA, MC adapter)
MicroSystems Development Tech., Inc.	POST Code Master	59.00	Displays POST codes, voltages (eight-bit ISA)
Sencore	PixPak	2,995.00	Test monitors in all modes up to 2,048 X 2,048
Ultra-X, Inc.	P.H.D. 16	799.00	Performs component-level diagnostics, displays POST codes, voltages (16-Bit ISA)
Ultra-X, Inc.	R.A.C.E.R. II	599.00	Performs component-level diagnostics, displays POST codes, voltages (eight-Bit ISA)
Ultra-X, Inc.	R.A.C.E.R. PS2	599.00	Performs component-level diagnostics, displays POST codes, voltages (Micro Channel)
Ultra-X, Inc.	Examiner	299.00	Detects IRQ & DMA channels (eight-bit ISA)
Ultra-X, Inc.	QuickPost-PC Plus	195.00	Displays POST codes, voltages; selects addresses (eight-bit ISA)
Ultra-X, Inc.	QuickPost PS2	195.00	Displays POST codes, voltages (Micro Channel)
Ultra-X, Inc.	Micro-P.O.S.T.	79.00	Displays POST codes; parallel & serial port loopback tester (Parallel Port)
Software			
Accurite Technologies Inc.	*Drive Probe*	199.00	Floppy drive diagnostic & alignment kit
AllMicro, Inc.	*Rescue Professional*	399.00	Recovers data from floppy, hard, Bernoulli disks
AllMicro, Inc.	*The Troubleshooter*	299.00	Self-booting general diagnostics
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CyberMedia	*First Aid*	49.00	Background diagnostics for *Windows*
Data Depot, Inc.	*Floppy Tune Deluxe*	199.00	Floppy drive cleaning, diagnostic, alignment kit
Data Depot, Inc.	*Floppy Tune Single*	129.00	Floppy drive cleaning, diagnostic, alignment kit for 3½" or 5¼" diskettes
DiagSoft, Inc.	*QAPlus/FE* 5.2	349.00	Self-booting general diagnostics
DiagSoft, Inc.	*QAPlus/Win* 6.0	99.95	General diagnostics for *Windows*
DiagSoft, Inc.	*QAPlus* 4.8	99.95	General diagnostics for DOS
E Ware	*WinSleuth Gold Plus* 2.0	99.95	General diagnostics for *Windows*
Gibson Research Corp.	*SpinRite* 3.1	129.00	Hard-disk maintenance & data recovery
Helix Software Co.	*Discover for Windows*	79.95	General diagnostics for *Windows* and included other tools
Landmark Research International Corp.	*WINProbe* 3.0	49.00	General diagnostics for *Windows*
Micro 2000, Inc.	*Microscope 6.03*	499.00	Self-booting general diagnostics
Micro 2000, Inc.	*911-Recover*	499.00	Recovers data from floppy & hard disks
Micro House International, Inc.	*DrivePro*	99.00	Hard-drive diagnostics
MicroSystems Development Tech., Inc.	*Test Drive*	115.00	Floppy-drive diagnostic & alignment kit
MicroSystems Development Tech., Inc.	*Port Test*	59.00	Serial- & parallel-port diagnostics
Sonera Technologies	*DisplayMate*	149.00	Monitor diagnostics for DOS
Sonera Technologies	*DisplayMate Professional*	249.00	Monitor diagnostics for DOS and commands to automate testing process
Sonera Technologies	*DisplayMate for Windows*	79.00	Monitor diagnostics expert system for *Windows*
Symantec Corp.	*Norton Utilities 8.0*	179.00	Data recovery & general diagnostics for *Windows*
Tall Tree Software	*UART Expert*	150.00	Checks UART chip of serial port
TouchStone Software Corp.	*WINCheckIt*	49.95	General diagnostics for *Windows*
Trackmate Inc.	4-in-1	22.95	Floppy drive cleaning & diagnostic kit
Windsor Technologies, Inc.	*PC-Technician PC3030 3.5*	195.00	Self-booting general diagnostics

Display Mate for Windows is an expert system that shows how to precisely set all of the parameters and controls and make adjustments on video monitors and video cards so that they work together as an optimized system. *DisplayMate Professional* is designed specifically for high-resolution and large-screen displays. A typical *DisplayMate* test screen is shown in Fig. 9.

• ***Data-Recovery Software.*** Data recovery isn't actually a "repair" procedure, such as replacing a defective memory module. But if you've ever lost data and then recovered it, you certainly feel as though you've completed a repair. Keep in mind that the UNDELETE utility in DOS can come in very handy if you accidentally lose some files. For more-serious problems, you may want to try some of the following products.

Though the $179 *Norton Utilities* from Symantec is widely known for its data-recovery ability, this product also fits well into the general diagnostics category. Version 8.0, for DOS and *Windows*, added such features as *Windows* configuration utilities, background disk repairs, a disk optimizer, a *Windows* system monitor, interrupt-conflict analysis and joystick testing. *Norton*'s Data Recovery screen is illustrated in Fig. 10.

AllMicro's $99 *Rescue* recovers data from most standard floppies and MFM, RLL, IDE, ESDI and SCSI hard drives, including most compressed drives. This program bypasses DOS and goes directly to the hardware disk controller to effect its recovery. The $399 *Rescue Professional* does essentially the same thing, but it also works with Bernoulli removable-media drives, drives that have a corrupted or lost primary partition, *Windows NT*-formatted drives and *LANtastic* and *NetWare LITE* formats.

Micro 2000's $499 *911-Recover* automatically repairs any software structure problems on hard and floppy disks, even if a disk isn't accessible from DOS. The program's Disc Analyzer determines the nature of any problems in a disk's partitions, master boot sector, directories, FAT tables, and so on.

Conclusion

If your interest in PC diagnostics is solely for your own benefit, there are a number of reasonably-priced hardware and software products from which to choose. They'll certainly help you get to know your system better and may also save you some money on repairs.

If your interest in PC diagnostics goes beyond your own system (perhaps you're a PC support specialist for a large company or you perform PC repairs and upgrades for a service center), there are many industrial-type hardware and software diagnostic products that should interest you. These products will assist you in locating problems in a timely way so that you can make intelligent decisions about whether to re-configure, repair or toss out a troublesome component or system. ■

Joe Desposito

text search, multiple file viewing and launch applications. Management features include directory and file find, move, delete and rename. Format support includes file formats from DOS, *Windows*, Macintosh and Unix. $49. *Mastersoft, Inc., 8737 E. Via de Commercio, Scottsdale, AZ 85258; tel.: 602-948-4888; fax: 602-948-8261.*

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Microsoft's *Automap Road Atlas* Version 4.0 trip planning software for North America includes such new features as better maps and graphics; richer information on states, counties, and cities; and new points-of-interest information, including more than 300 ski resorts in North America. $39.95. *Microsoft Corp., One Microsoft Way, Redmond, WA 98052; tel.: 206-882-8080; fax: 206-93MSFAX.*

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EasyFlow for Windows Upgrade

EasyFlow for Windows Version 2.0 charting and diagramming software from Haven-Tree Software incorporates a number of new user-friendly features and options. Some of these include diagonal and curved lines that manually link together shapes, contact-sensitive gizmos that display the attributes of selected objects and on-screen hints for tools and status bars. $199. *HavenTree Software, PO Box 470, Fineview, NY 13640; tel.: 613-544-6035; fax: 613-544-9632.*

CIRCLE NO. 26 ON FREE CARD

Scientist for Windows Upgrade

MicroMath's *Scientist for Windows* Version 2.0 is dedicated entirely to fitting model equations to experimental data. This new version has sophisticated equation-editing capabilities, permitting technical document preparation within the *Scientist* editor. Also, graphics interaction has been improved. The Version 2 editor is much more powerful than in the previous one. The model parsing, error-trapping and numerical routines have all been refined and improved. $395. *MicroMath Scientific Software, 2469 E. Fort Union Blvd., Ste. 200, PO Box 1550, Salt Lake City, UT 84121; tel.: 801-943-0290; fax: 801-943-0299.*

CIRCLE NO. 27 ON FREE CARD

Model-Train Software Upgrade

Digital Power's *REALROAD Throttle Simulation* Version 1.5 model-train simulator actually operates model trains. This software lets you quickly set up and simulate prototype trains. The user's model trains, which the system controls, respond exactly as the prototype would. The *REALROAD* system combines a Motor Discovery process on the locomotive, using the FMA Precision Power Digital Throttle (a PC add-in card) that aids the computer in learning the operational characteristics of the electric motor in the model locomotive.

New features include scale-model locomotive and trip odometers, a No Stall digital signal processing algorithm that greatly enhances low-speed performance on all locomotives, a larger database of locomotives, and others. $279.95. *Digital Power, Inc., Dept. F, PO Box 130472, St. Paul, MN 55113; tel.: 612-572-4240; fax: 612-595-9772.*

CIRCLE NO. 28 ON FREE CARD

Books

The Microcontroller Idea Book

By Jan Axelson

(LakeView Research, 2209 Winnebago St., Madison, WI 53704. Tel.: 608-241-5824. Soft cover. 277 pages. $31.95. Program Disk $5 extra.)

Written by regular author in *MicroComputer Journal* Jan Axelson, this book provides a hands-on guide to practical designs for use in dataloggers, controllers and other small-computer applications. It includes complete schematics, parts lists, design theory, construction and debugging tips and example programs. It shows how to add a multitude of devices like keypads, switches, displays, sensors, clock/calendars, motor controls, wireless links and other I/O interfaces.

Each of this book's 15 chapters and three appendices covers a specific topic for easy look-up. It starts with a chapter on microcontroller basics and follows with another chapter that takes you on a tour inside the 8052-BASIC chip. Then its gets into 10 chapters of hands-on material like powering up, saving programs and programming. It continues with inputs and outputs, switches and keypads, displays, using sensors to detect and measure, clocks and calendars, control circuits and wireless links. Rounding out the coverage, the next topics are devoted to controlling assembly-language routines, running BASIC-52 from external memory and related products. The appendices cover sources like books, BBSes and product vendors; programs for loading files; and number systems.

This is an excellent resource for anyone who is interested in building projects around the 8052-BASIC microcontroller. Its coverage is complete, and the material is well-written and equally well-illustrated.

Introducing Desktop Video

By Tom Benford

(MIS:Press. Soft cover. 332 pages + CD-ROM. $34.95.)

Columnist and frequent contributor to *MicroComputer Journal* Tom Benford has distilled some 25 years of experience in video production work to bring this book and CD-ROM combo to fruition. This is one of those "Everything You Always Wanted to Know..." books in that it covers just about everything there is to know about producing professional video on a PC. It's a hand-holding how-to guide that, through lively text and clear illustrations, answers your questions almost before you have time to formulate them.

With this book, you set the stage for producing videos that will make you proud. You'll learn how to plan every step of a production, from scripting to the final polished video. Along the way, you'll learn how to install and use Intel's Smart Video Recorder Pro capture card, how to get the best digital transfer of sound and video, and much more than the limited space here allows us to cover. Some of the material you'll learn includes how to add sound, morphing and other special effects to a production. You'll explore desktop software with an emphasis on *Video for Windows*.

The accompanying CD-ROM demonstrates what you can do using the techniques and procedures detailed in the book. On the CD-ROM are a run-time version of Microsoft's *Video for Windows* and the Intel *Motion Video Player* that should get you started making your own video productions.

This excellent resource should be in the library of everyone who is interested in video productions on a PC. It's a great introduction for amateurs who want to do fun and constructive things, and it should prove useful to people who are already involved in desktop-video production work. The included bonus CD-ROM is the cherry on the top of this delightful sundae.

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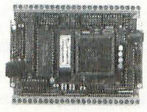

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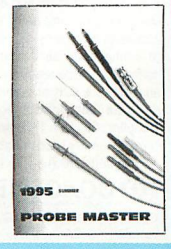

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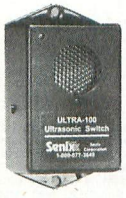

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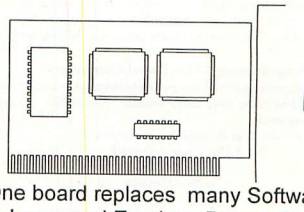

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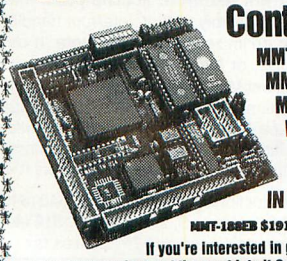

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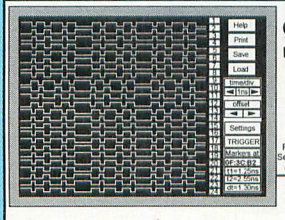

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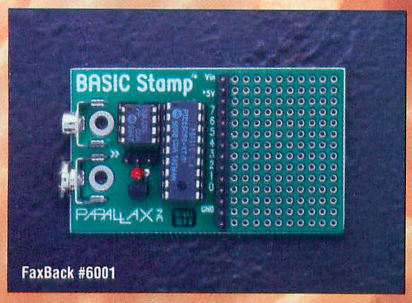

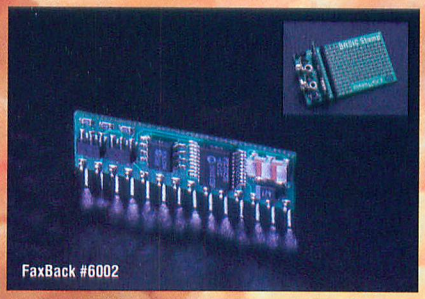

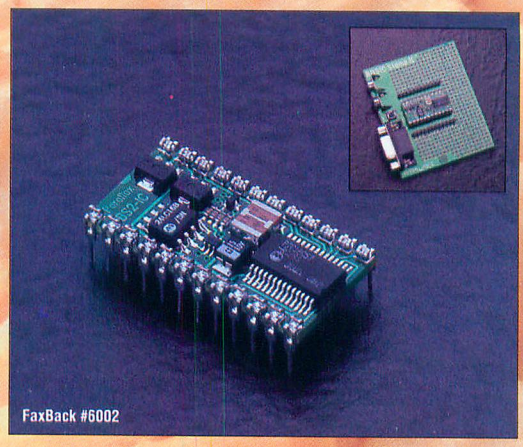

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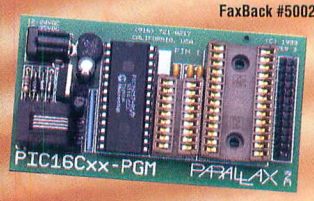

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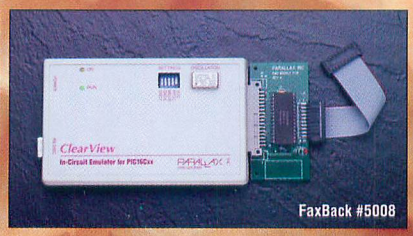

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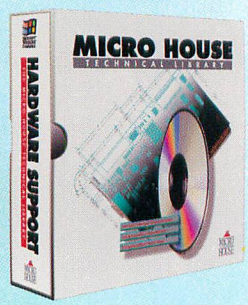

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